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APRIL 2015

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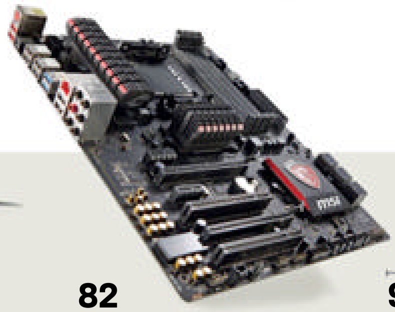

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Tuan
Nguyen

THE PC'S NEXT BIG WAVE

A LOT OF PEOPLE WRITE IN to ask what we think will be the next big thing each year. For a while now, finding a legitimate answer has been genuinely difficult, since the industry seemed to have stalled. Not so this time around.

This year, there's a lot to be excited about. The juggernaut that's moving us forward is virtual reality. Yes, VR has been around as a term for years, but it wasn't until very recently that there was something substantial to write home about. Lots of companies, both large and small, are getting involved in virtual reality now. The key here is that VR will drive innovation in all sorts of categories for the PC.

The first area that will see immediate impact is in the GPU department. To deliver on the promise of "presence," GPUs need some serious development. The two GPU biggies, AMD and NVIDIA, are already hard at work on this front.

The second area that will be affected has to do with input. VR will spur the development of improved and new input devices as well as sensory devices. Not being able to see your limbs inside a VR environment can be jarring, and this needs to be addressed. Being able to reach out in VR space and see your body in it will contribute greatly to a sense of presence and immersion.

Other areas that will see innovation will include audio technology, and combining VR with augmented reality systems. Companies such as Magic Leap are attracting huge funding and filing patents, while Microsoft just announced its jump into VR in a huge way as well with Windows 10 and HoloLens, a hybrid VR/AR system. Funnily enough, Microsoft's killer app for HoloLens may just turn out to be *Minecraft*. All of this, of course, is awesome news for the PC and the wider PC ecosystem. Everything from games to entertainment content will be impacted.

I believe this is going to be the next big wave for the PC that we've all been waiting for. I truly miss the days when accelerated 3D hardware started a rush in development and games. There were so many competitors making 3D graphics hardware back then that it seemed impossible the field could be be winnowed down to the two that now remain. Everyone remembers 3dfx, but there were other innovators moving the PC forward as well, such as Rendition, Matrox, PowerVR, and Number Nine, to name a few. Then there were the board makers. Exciting times.

Now we're on the verge of another positively disruptive era. It's a good time to be in the PC industry, and those of us who've been around for a long time are on the edge of our seats. This is going to be one helluva ride. No BS.

Tuan Nguyen is Maximum PC*'s editor-in-chief, also known as "the pointy end of the stick." He's been writing, marketing, and raising hell in the tech industry for 19 years.*

↘ submit your questions to: comments@maximumpc.com

THE NEWS

Microsoft to Push AR and Free Win10

For the first year, anyway, if you're upgrading from Win7 or 8

AFTER ABUNDANT churning of the rumor mill, Microsoft held its Windows 10 press event last month and confirmed its upcoming operating system would be free to Windows 8, 7, and Windows Phone users—for the first year at least. The Redmond company views it as an incentive for users to quickly jump on board the Windows 10 platform, and believes this will solve one of the biggest OS issues for developers—OS fragmentation. Microsoft is keeping quiet, however, about how Windows 10 will be priced beyond the intial year.

Another rumor Microsoft confirmed was that Windows 10 will support Cortana, which the company is pitching as the OS's personal digital assistant. In short, Cortana is based on the AI character from the *Halo* games, and is Microsoft's answer to Apple's Siri.

Microsoft is creating a new browser to go along with Cortana. Codenamed Project Spartan, the browser will use a new rendering engine and will support note-taking with either a stylus or a finger. Project Spartan will also let you click on words and phrases to leave comments. You'll then be able to share pages (including your comments) on the various social media outlets.

Microsoft revealed a host of new products to go with Windows 10.

The company also wants to push gaming with Windows 10. “We will treat gaming on Windows 10 with as much passion as on Xbox One,” said Phil Spencer, head of Microsoft's Xbox division. In addition to supporting DirectX 12, which the company (somewhat vaguely) stated will run up to 50 percent faster than DX11 equivalents, the company announced that users will be able to stream Xbox One games to any Windows 10 PC over a local network. This includes streaming to Windows 10 tablets and convertibles.

Microsoft also revealed the Xbox app, which will allow you to capture and record the last 30 seconds of gameplay in any PC game, much like Nvidia's ShadowPlay feature. This includes games from Steam, Uplay, and Origin.

Beyond the gaming stuff, Microsoft went over a multitude of other OS updates. Windows 10 will work across a wide variety of devices including phones, tablets, desktops, and laptops. Power desktop users worrying that their OS will be compromised with a mobile OS (à la Modern) needn't worry, because the Start button is indeed back. There is, however, a tablet mode where the Start button opens up and shows many more touch-friendly icons. But unlike Modern, which was quite in-your-face, users can ignore this altogether if they so desire.

Surface Hub was also announced. This is a Windows 10 PC integrated into an 84-inch 4K TV with a mic, cameras, and touchscreen. Using it, you'll be able to use a stylus to draw on PowerPoint presentations.

Microsoft, however, saved the best for last. Its final announcement was arguably the most exciting—HoloLens. Many suspected that Microsoft would release a head-mounted display for VR to compete with Oculus Rift/Project Morpheus. The company, however, opted to go the augmented reality route.

HoloLens is a head-mounted display, but unlike VR headsets, it grants you full vision of your surroundings, with a clear glass overlay in front of your eyes. A video feed beams into an area of the glass in real time. The end result is virtual objects lying around your real space. Then there's the HoloStudio app, which will be used to easily build 3D models with your hands. Microsoft is calling it the best print preview for 3D printing out there.

Although no specific dates were given, Microsoft tells us that you should be able to get your hands on Windows 10 sometime this year. **–JT**

> “
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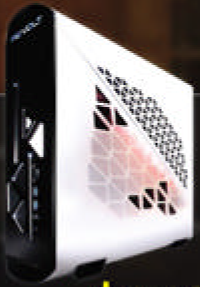

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MICROSOFT ANNOUNCES AR HEADSET

Sidestepping the VR rivals with HoloLens

HoloLens will be wireless and run on Win10.

MICROSOFT HAS SURPRISED THE WORLD by unveiling HoloLens, an augmented reality headset already well into development. AR is similar to virtual reality, except it integrates 3D objects into the world around you, instead of putting a fully computer-generated scene in front of your eyes.

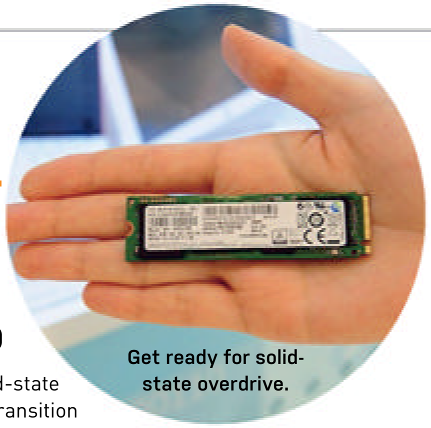
While the demo kit was wired and featured a chest mount tethered to a janky-looking headset (so janky that Microsoft wouldn't let us take pictures of it), the company says the consumer version will be completely wireless and not require a separate device. Nor will it require markers or have an external camera, even though it supports positional head-tracking. Instead, it will run Win10 itself and have its own CPU, GPU, and a new holographic processing unit (HPU) that processes all of the sensors together in real time.

The headset also has integrated speakers that provide spatial sound and a built-in mic to issue voice commands. In addition, HoloLens has an integrated depth sensor, supports stereoscopic 3D, and can track your finger gestures (provided they are in your line of sight). Activating a command is as easy as holding your fist one foot away from your chest (with your knuckles facing you), lifting your index finger up to the ceiling, and flicking up and down with said finger.

Microsoft has so far been coy about specs. When we asked about resolution, the answer was merely "HD." In theory, this means 720p and up. Regardless, from our experiential tests, we didn't have any major issues with the resolution and thought it looked quite sharp for a developer kit. Of course, we'll take higher resolution any day, but what Microsoft is currently running seems ready for consumer release, which the company says will happen in the Windows 10 launch timeframe. **–JT**

SAMSUNG READIES WARP-SPEED SSDs

THE PCIe REVOLUTION IS FINALLY GETTING STARTED



Get ready for solid-state overdrive.

ONE OF THE BIG CHANGES currently hitting the solid-state drive market is falling prices. But there's also the transition to PCI Express, which brings with it much faster speeds. How fast are we talking? Well, Samsung's SM951 SSD for ultra-slim laptops and workstations is rated to read and write data at up to 2,150MB/s, and 1,550MB/s, respectively. Samsung's drive also supports PCIe 2.0. When installed in a PCIe 2.0 system, it can read and write data at up to 1,600MB/s and 1,350MB/s, respectively, along with random read speeds of up to 130,000 IOPS and random writes of up to 85,000 IOPS. The SM951 is also the first SSD to adopt the L1.2 low power standby mode. **–PL**

GO WIDE! THERE'S A NEW WAVE OF MONITORS COMING

Manufacturers to satisfy 'cinematic' demand

PANEL MAKERS SEE 34-INCH WIDE QUAD HIGH DEFINITION, or WQHD (2560x1440), monitors to be the new high-end option, according to industry sources speaking to tech website Digitimes. At present, this tier has primarily 30-inch panels at 2560x1600 and, more recently, 32-inch 4K displays. There are fewer pixels in a WQHD display, but it's still visually appealing, easier on the GPU for pixel-intensive tasks (primarily gaming), and the 21:9 "ultra-wide" ratio offers tons of horizontal screen space. They're also experimenting with curved displays, wide color gamuts, and 10-point touch features. Finally, monitor makers also plan to push out 24-inch, 27-inch, and 28-inch 4K screens, and even 5K sometime in 2015. **–PL**

AOC's U3477PQU monitor.

Tech Tragedies and Triumphs

A monthly snapshot of what's up and down in tech

TRIUMPHS

YOUTUBE UNPLUGS FLASH
The king of video streaming sites announced it's replacing Adobe Flash with HTML5 as its default choice.

SOUTHERN HOSPITALITY
Google announced it will bring its fiber service to 18 cities in the southeastern US, centered around Atlanta and Raleigh, NC. Yee-haw!

BROADBAND REDEFINED
The FCC has voted to change the definition of broadband, upping the minimum download speed from 4Mb/s to 25Mb/s. Hey, it's a start.

TRAGEDIES

SPECTRUM BLOWOUT
AT&T and Verizon spent a combined $28.6 billion on the FCC wireless auctions. Up-and-comer T-Mobile wrangled "only" $1.8 billion.

WINDOWS 10 BACKTRACKING
After saying Windows 10 would be free for everyone, Microsoft clarified that RT and also some Windows phones would be left out.

YOUR PASSWORD SUCKS
"Batman" and "Superman" make it onto a list of the 25 most-used passwords, as does "trustno1."

Tom Halfhill

FAST FORWARD

The Four Sides of 3D Chips

THREE-DIMENSIONAL FLASH MEMORY is the latest chip technology that's truly revolutionary and Samsung is leading the way with its 3D-NAND flash-memory cells in 500GB SSDs. Multiterabyte SSDs will soon follow. It's the biggest news in semiconductor tech since 2011.

SAMSUNG
Solid State Drive

Samsung's 850 Pro was the 3D revolution's trailblazing SSD.

That was the year when Intel revolutionized digital logic by mass-producing the first microprocessors with three-dimensional finFET transistors. But it's also causing confusion. Samsung's 3D-NAND flash memory is completely different. Different again is a 3D-stacked chip. Heck, some folks are even confusing these innovations with 3D-graphics processors. They're all different. But they do have one thing in common—they're solutions for cramming more transistors into less space.

Flash memory urgently needs help because atomic-level physical limitations prevent it from getting much denser, faster, or cheaper. Whereas DRAM and SRAM cells quickly lose all their electrons when powered down, flash cells preserve data by trapping electrons in a "floating gate" (a conductive material) sandwiched between two insulators. Eventually, the trapped electrons escape, but not for years. The retention time depends on several factors, including the number of trapped electrons and whether they're disturbed by electrical activity.

But transistors are getting so small that the number of electrons they trap is getting alarmingly low. Ten years ago, a typical NAND-flash bit cell retained about 1,000 electrons per bit. Now it's about 50. Even worse, some flash memory stores more bits per cell by sensing multiple voltage levels. With a conventional single-level cell (SLC), only one voltage level spells the difference between a one or a zero (one bit). A multilevel cell (MLC) stores two bits by using four voltage levels. A triple-level cell (TLC) stores three bits in eight levels. The more levels, the fewer electrons per level.

> It packs more cells into the same space without shrinking the transistors. This solution seems obvious, but the manufacturing details are devilish.

Leaking only a few of those electrons can evaporate your data. Also, repeated read/write operations permanently trap some electrons, which prevents the cell from flipping between one and zero, making it useless. That's why flash drives use wear leveling to evenly distribute the operations. To overcome these problems, 3D NAND stacks the bit cells vertically. It packs more cells into the same space without necessarily shrinking the transistors and compromising their data retention and endurance. This solution seems obvious, but the manufacturing details are devilish.

Intel's finFETs (finned field-effect transistors) solve a different problem. A logic transistor must leak as few electrons as possible through its gate when switched to its "off" binary state. But as transistors keep getting smaller, their gates get shorter, enabling more electrons to escape. By fabricating transistors with a vertical fin rising above the chip's surface, Intel ups the gate's effective length without using more horizontal space. These 3D transistors aren't stacked, as they are in 3D-NAND; they are "3D" in comparison with a conventional planar (flat) transistor.

Stacked chips are another "3D" variation. They simply pile two or more silicon die on top of each other. Usually these "3D" chips are designed to save board space in small systems like mobile phones. A 3D-graphics processor is yet another breed. It's simply a microprocessor optimized to run 3D-graphics software. It needn't use any of the 3D technologies described above.

Confusion arises, even among gearheads, when we use vague terms like "3D" to describe very different technologies intended to solve very different problems.

Tom Halfhill was formerly a senior editor for *Byte* magazine and is now an analyst for *Microprocessor Report*.

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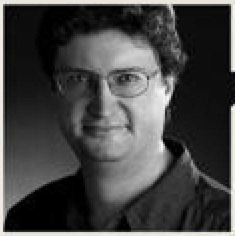


Thomas L. McDonald

GAME THEORY

Mood-Making Puzzles

I KEEP READING END-OF-THE-YEAR STORIES complaining about what a rotten year it was for PC gaming. There have certainly been better years, but I found enough out there to keep me interested, particularly when looking in the more hidden corners where unfinished, solo, and generally tiny projects lurk waiting to be discovered.

It seems like most magazines and websites are throwing their 2014 Game of the Year awards at *Dragon Age: Inquisition*. I have no problem with that. It's an impressive piece of work, but I think I'm suffering Bioware fatigue. I've had enough Biodialogue-trees and Biorelationships and Biocombat and Bioquests to hold me for a while. There's a kind of diminishing return as relationships and dialogue get more detailed and realistic, or as realistic as fantasy dialogue can get. It's like an uncanny valley for encounters: the more sophisticated they get, the less right they feel.

The title that gave me the most delight was on iPad not PC, yet it offers lessons that PC designers should take to heart. *Monument Valley* by Ustwo is a small game. It won't take you long to finish, and it's not very challenging, but what it offers is such a pure experience of gaming rightness that it almost demands to be deconstructed to learn just what makes it work so well.

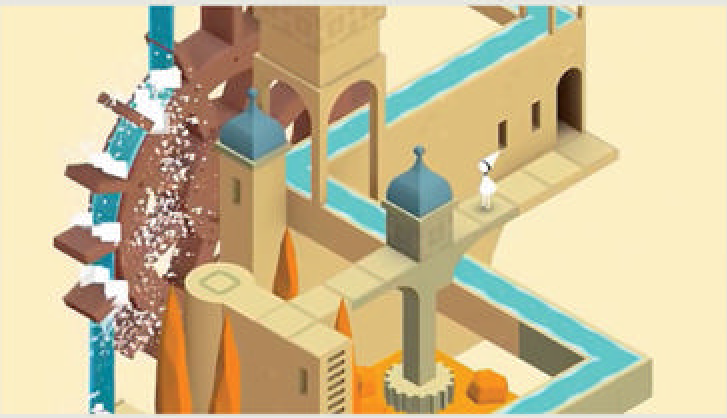
At first glance, the most striking thing is its visual style. Drawn with clean lines and calming colors, it packs a lot of information into its shifting, single-screen puzzles. The most obvious comparison is with the artwork of M.C. Escher, the surrealist genius whose impossible architecture is at the heart of *Monument Valley*'s world and puzzles. We've seen impossible architecture before, as in the non-linear structure of *The Stanley Parable*, but here the single-screen design and optical puzzles feel like falling into an Escher painting.

Almost as striking, however, is its simplicity. As a puzzle game, it won't stop anyone for very long, and that's kind of the point. *Monument Valley*—through its use of visual design, music, sound effect, fluid motion, and measured pacing—offers a mood and an experience that's just as important as its logic challenges. Harder puzzles would pop you out of that experience and move the mood to one of deeper concentration or even frustration. As it stands, its challenge-to-simplicity ratio is perfectly poised: just hard enough to be make you think a bit, not hard enough to be annoying.

Creating and sustaining mood through puzzles is very hard to do well, but it shows the connections that can be made among different areas of the mind—the aesthetic sense, emotions, and the intellect—that too often strain in opposite directions. It's one thing to sweat over a puzzle, but quite another to experience a world that is itself puzzling, and remain in that world while you manipulate its unique rules to find a solution.

Thomas L. McDonald has been covering computer gaming for over 25 years.

> *Monument Valley* offers lessons that PC game designers should take to heart. It won't take you long to finish, and it's not very challenging, but it offers such a pure experience of gaming.



Monument Valley's simple, striking levels were 2014's most enjoyable.

THE LIST

THE 8 COOLEST THINGS AT CES 2015

8 INTEL COMPUTE STICK

Who knew you could fit a Windows 8.1 PC into an HDMI stick the size of a Chromecast?

7 CYBERPOWER TRINITY PC

The Trinity PC reminds us a little of Razer's Project Christine, except that it's real.

6 GIGABYTE WATERFORCE COOLER

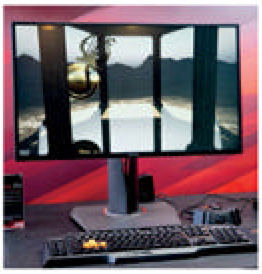
This is the craziest closed-loop liquid-cooling system we've ever seen.

5 RAZER FORGE TV

Play Android games and stream PC titles to your TV for $100.

4 DIGITAL STORM AVENTUM 3

This was undoubtedly the most beautiful desktop this year.



3 ASUS ROG SWIFT PG27AQ

This is a 27-inch 4K IPS display that's G-Sync compatible. Nice.

2 MSI GT80 TITAN

This highly modular gaming laptop features two 980Ms in SLI, and has a mechanical keyboard.

1 LENOVO LAVIE

At 1.7 pounds, this is the lightest notebook we've ever held.

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TALKING

Believe the VR Hype

From that Facebook buyout, to needing a seriously beefy rig, Oculus Rift co-founder Nate Mitchell tells all in the *Maximum PC* interview

Oculus Rift has had a busy life since its inception just over two years ago, but with big money and plenty of expectations floating around, many questions remain about both the Rift technology and the future of virtual reality in general. *MPC*'s Jimmy Thang caught up with Oculus VR's Nate Mitchell at CES 2015 to give him a hard time, so you don't have to.

Maximum PC:
For those readers that might have been people living under a rock for the past two years or so, can you tell us a little bit about Oculus VR?

Nate Mitchell:
Oculus is a company dedicated to bringing great consumer virtual reality to life. We're focused on two products right now. Firstly Gear VR on the mobile side, which is a product we've just launched with Samsung. Gear VR Innovator Edition is all about convenience and portability. Sort of VR anywhere, really high-quality VR experience anywhere.

Oculus has already shipped 125,000 dev kits.

And then there's the Oculus Rift. We launched the kickstarter for the Oculus Rift developer kit back in 2012 and since then we've been working on different iterations of the hardware—we debuted with Crystal Cove, then there was DK2. We are now showing Crescent Bay for the first time publicly here at CES 2015. And all of this is leading up to the consumer launch of the Oculus Rift.

MPC:
And, we have to ask, when do we expect to see that?

NM:
There's no release date at this time. Unfortunately. It's the question we always get. We're on track though.

MPC:
There was some controversy when you were bought out by Facebook for $2 billion last year. Has that hatred gone now?

NM:
I think a lot of the initial anger has subsided. Some people are still... skeptical, shall we say. They're skeptical of the relationship between Oculus and Facebook. I think a lot of that initial gut reaction has gone away, but people are still skeptical that Facebook isn't going to sort of poison Oculus.

All that said, in the last almost-a-year or so since we announced the Facebook acquisition, things have gone incredibly well. And I think people would be hard pressed to point to anything that Facebook or Oculus has done that has been different from our original mission.

We open sourced DK1, the SDK stayed largely open source, we've ramped the team way, way faster than we would have been able to otherwise, we've been able to do two products simultaneously, and we're creating the best team in the world: [John] Carmack, [Michael] Abrash, Brendan Iribe, Michael Antonov—it's an incredible group.

The onus has always been on us to prove that it was the right decision, but when we looked at whether it was the right decision for us, we really framed it against one question, and that was—what is the best thing for VR? How do we get consumer VR to change the world? And joining forces with Facebook just seemed like the obvious way.

MPC:
Mark Zuckerberg said that for VR to be meaningful he was hoping to sell it to 50 million people. What do you think about that?

You'll need Crescent Bay to see what Nate Mitchell is holding here.

NM:
I think VR is going to be meaningful in an impactful way, before 50 million units are out there. But I think 50 million units will come faster than many people might expect, especially when you have so many different players coming out—whether that's Sony, or we saw some announcements from Razor getting in the VR space, and there's been rumors about Google and Microsoft. I think we're seeing all these major players dive in, and virtual reality is taking off as a platform and as a medium.

As soon as there are a significant number of units out there, developers can then build content and start building successful businesses against virtual reality. And that's one of the key inflection points we're all waiting for. After that I do think that VR is just going to continue to take off. Fifty million is an ambitious number, but I don't think they all have to be Oculus Rifts for VR to fundamentally change the way we live.

MPC:
What do you have to say to the people that haven't had a chance to try the Rift, that say there's no release date, that it's vaporware?

NM:
You have to see it to understand it. Anyone who's seen the Rift, especially Crescent Bay, knows that it's not vaporware, although obviously not many people have had a chance, as this is our first public debut here at CES. But if you've seen DK1, DK2… I mean we've shipped over 125,000 units to date, development kits. Those are all out there in the wild, with developers and enthusiasts.

Gear VR just launched. It's sold out. We have Crescent Bay here at the show—you try it and you understand what this whole thing is about. But until you try VR… for some people, they try DK1, a taste of VR, and they say "that's not going to work." We've still got a long way to go. You try Crescent Bay and it's a fundamentally different experience and you get it. You don't have to extrapolate so far. You understand why VR is going to be so impactful, and why it's just around the corner rather than far out. So, I would say to them, stay skeptical, but when you have the opportunity, go and see it. You will understand why this is so important, especially for games.

MPC:
Crescent Bay runs at 90Hz. Can we expect the consumer release to be 90Hz as well?

NM:
You can expect it to be at least 90Hz, if not higher. Which is interestingly enough a big challenge on the PC side—you're going to need a pretty hefty GPU to drive this thing.

When you think about it, even at 1080p, a 90Hz display, when you're rendering stereo, that's really heavy processing power that most modern games today aren't even designed to run at. For the big PC fans out there, you're in luck, you are going to need a great rig to power the Rift.

Over time we do want to bring that to lower-end hardware, but to really get the quality experience and fidelity that we want to deliver, especially for V1, it is going to be a high-end card. And the machines we're using today for the Crescent Bay demos, they're running Nvidia 980s, which are high-end cards.

MPC:
Having used DK1, DK2, and Crescent Bay, it seems that Oculus is making a lot of improvements, especially in the realm of motion sickness. How are you overcoming that?

NM:
That's a big question. There are two parts to it—one is the system itself and the other is content. Let's pretend we have a VR system that is perfect in every way, shape, and form, and can simulate reality perfectly.

If then you have a piece of content, where let's pretend you're on a merry-go-round going at a hundred miles an hour. You're going to get dizzy just as you would in real life. The game will simulate that extremely well and the system will simulate that well and you'll actually feel disoriented.

MPC:
Except your body isn't actually going to be moving, so that's going to feel even more disorientating in some ways…

NM:
Exactly. Absolutely. That disconnect between what you're seeing, the optical flow, the vection, and your vestibular system, is going to cause problems. So, the content is always a challenge and we've been working with developers. We have a best practices guide, but really it comes down to what developers want to create and what users want to consume.

On the hardware side we've dedicated a huge amount of research and time and energy to nailing the system down so that everyone can have a comfortable experience. It's a mix of ergonomics, resolution, the optics, distortion.

Positional tracking's required, we think low persistence is required, 360 degree tracking is also really important (depending on the types of experiences you're trying to recreate), and minimizing latency is of course also really important.

Check out the full interview over on the *Maximum PC* website: http://bit.ly/1LPi6N2

DOCTOR

THIS MONTH THE DOCTOR TACKLES...

> Storage Diagnostics
> Blu-ray Playback
> PCIe Compatibility

Multiple Displays

I like to keep websites open or watch a movie on my secondary monitor while gaming. Would using a USB-attached device like an HP DisplayPort for the second display give me much of a performance increase, while having the videocard drive one monitor? Or could the USB setup even be detrimental?

—Christopher Kashuba

THE DOCTOR RESPONDS: Almost certainly, you're best-off driving both monitors from your graphics card. But the definitive answer isn't as simple. The Doc believes you're talking about using Display*Link* technology to attach a second display (HP sells a DisplayLink-equipped screen called the U160 with a native resolution of 1366x768). This involves compressing screen updates and sending them off over USB. Certain apps are well-suited to this, others aren't. A website won't change much over time, so it won't require much host processing or peripheral bandwidth. Movie playback, however, will be laggy, full of artifacts, and much more resource-intensive—not a good fit for DisplayLink.

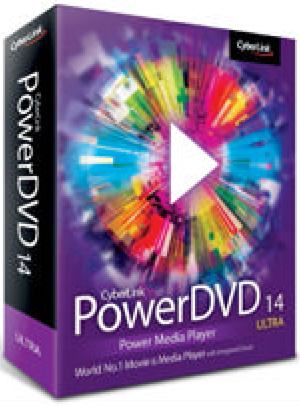
Even if you have to play your game in Windowed (Fullscreen) mode so you can drag your mouse to the other monitor without "tabbing out," which could sacrifice performance, connecting a second monitor to your graphics card would be the Doc's tip. We'd only consider a USB-attached display as a productivity tool for word processing or email on the go.

Testing Times

I've obtained some used SATA hard drives. I'd like to run a thorough test on each one to help me judge whether to put them back into use. I'm wondering which utility software (free or for purchase) you'd recommend I could put on a bootable CD or USB flash drive to test them? Thanks for your great magazine.

—Brandon Coale

THE DOCTOR RESPONDS: You're right to be wary of putting used mechanical disks back into action. Fortunately, this is one of those cases when free software should address your needs. Without knowing which company manufactured the drives, the Doc suggests you visit the vendor-in-question's support site and download whatever tools you can find for proactively identifying damaged disks.



A good Blu-ray decoder like PowerDVD avoids legally-questionable workarounds.

Seagate, for instance, offers its SeaTools for Windows utility, supporting the company's internal and external storage products (the app is compatible with Maxtor and Samsung drives as well). It'll attempt to fix any bad sectors it encounters, prompt you when a firmware update is found, write zeros across a drive to erase it, or let you restore the password on an FDE-capable disk. Western Digital's equivalent is called WinDLG (for Data Lifeguard), while Toshiba publishes a Windows Diagnostic Tool for Fujitsu-branded hard drives, too.

There's also a handful of useful third-party utilities. HDDScan, for example, performs a number of different tests, presents S.M.A.R.T attributes, provides access to power management settings, and monitors temperature information. The free version of HD Tune includes some of the same functionality, but adds a low-level benchmark for gauging the performance of your hard drive. Plenty of other options exist. But between the manufacturer-supplied tools and the best freeware utilities, you should get a good sense of drive health.

The Blu-ray Blues

Dear Doc, I need some serious help. I cannot play any type of Blu-rays through VLC, Roxio CinePlayer, or anything. I have searched the Internet, forums, and everything known to man. You should have been my first to contact. VLC keeps saying this: "Blu-ray error: This Blu-ray Disc needs a library for AACS decoding, and your system does not have it. Your input can't be opened: VLC is unable to open the MRL 'bluray://D:/'. Check the log for details." Can you please help me?

–John

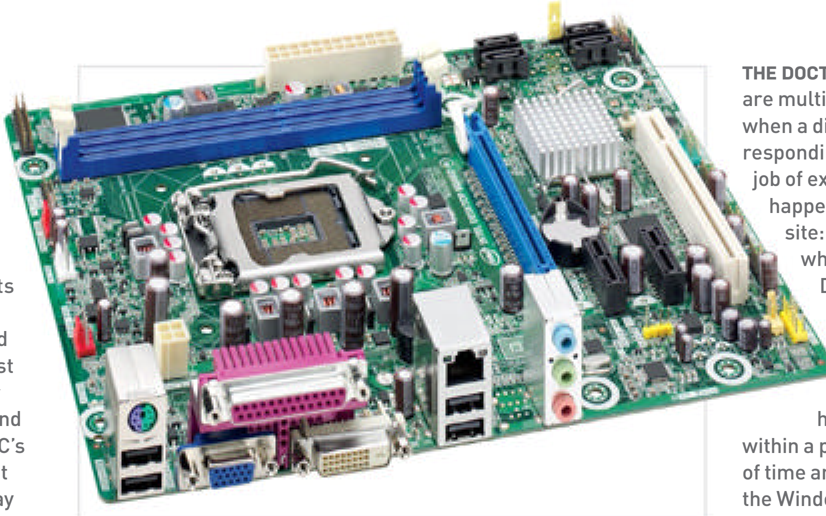
THE DOCTOR RESPONDS: Roxio's CinePlayer software is designed for DVD playback (pre-Blu-ray) under Windows Vista or XP. VLC, the Doc's own favorite freely available media player, does come with the libdvdcss library for reading CSS-encrypted DVDs, but

↘ submit your questions to: doctor@maximumpc.com doesn't natively include the keys for decrypting the Advanced Access Content System (AACS). At least by default, neither of those media players are going to work. The same goes for Windows Media Player.

Now, we're all enthusiasts here, so the Doc won't pretend the two files needed to get VLC working with most Blu-ray discs *aren't* all over the Internet. In fact, you'll find instructions at the top of VLC's own forum for Windows. But circumventing AACS this way *isn't* legal. And newer movies employ updated protection mechanisms that frequently thwart workarounds.

Your best bet is finding Blu-ray playback software you'd be comfortable paying for. CyberLink's PowerDVD and Corel's WinDVD are two Windows-based options. Regular updates ensure you can play the latest releases and get support for next-gen formats like HEVC. Alternatively, you could buy SlySoft's AnyDVD HD, which defeats AACS, allowing players to read decrypted audio and video formats. The software's legality is unclear, but it remains available for $73. Regular updates, published through a subscription system, keep AnyDVD current with the latest protections schemes.

The Doc isn't trying to hawk software here. Sometimes freeware gets the job done. But part of being a power user is recognizing when a purpose-built solution is the way to go. There's no shame in dropping $50 on good decoder software.



Intel's DH61CR mobo sports a 16-lane second-gen PCIe slot, which should have no problem supporting Nvidia's GeForce GTS 450 GPU.

PCI Problems

I have an Intel DH61CR motherboard (with current BIOS revision), a Core i3-2100 CPU, and 4GB of RAM. The CPU has on-die graphics, but I decided to install an EVGA GeForce GTS 450 videocard. The motherboard BIOS did not recognize it, though. I finally found an Intel document on the company's download site stating this: "PCI cards that utilize a PCI Express to PCI bridge component may not work with Intel Desktop Boards based on the Intel 6 Series Chipset." My problem is how I purchase a videocard and know if it will work as most places don't allow returns after they've been used. Can you help? I'm interested in the GeForce GT 730 or similar, but not sure it will work?

–JB

THE DOCTOR RESPONDS: As far as the Doc's seen, there's no PCI Express to PCI bridge chip on the GeForce GTS 450—your graphics card should sport a GF106 GPU, with native support for PCIe 2.0. Moreover, Intel's manual is pretty specific that the board's BIOS automatically detects and configures add-in cards. You don't need to mess with firmware settings to get your card working. Good news, right? So, what else could be wrong? Time to troubleshoot!

You'll have to excuse the Doc if some of this sounds obvious. Diagnosing a problem is all about eliminating possibilities. Start with the power. EVGA's GeForce GTS 450 lineup has a 400W minimum power supply requirement, with at least 22A of current on the +12V rail. Check your PSU's specs to compare. Does your model (EVGA lists nine versions on its site) have a six-pin power connector? If so, that needs to be connected. Make sure the card is seated properly, too. Confirm the GeForce's fan spins up when you apply power.

How about your monitor configuration? You plugged your display into the add-in card, rather than the mobo's integrated output, right? And if you switched from, say, VGA-out to DVI, or DVI to mini-HDMI, did you ensure the monitor is set to the right input?

There's always the chance your card is dead or your mobo's slot is damaged. Don't let that dissuade you from trying again, though. Standards like PCI Express exist to facilitate compatibility between host and client devices. In short, there's no technical reason why your motherboard and graphics card, both PCIe-compatible, shouldn't work together.

Graphics Woes

Hi *MaxPC*! I love the magazine! Thanks to you, I've built a heck of a gaming PC! But... I have an HP Pavilion dv7 laptop with Windows 7 64-bit and a Radeon HD 6770M videocard. All updates and drivers are up to date. It works great except that Microsoft Access frequently crashes the display driver. The screen goes black, blinks, and then resets with a dialog box telling me the display driver has crashed and recovered. I can leave Access open, unattended, without an issue. But just typing text into a field can set it off. Typing s-l-o-w-l-y doesn't cause a crash. Any idea how to fix this very annoying problem? Thanks!

–Ken Sexton

THE DOCTOR RESPONDS: There are multiple possible culprits when a display driver stops responding. AMD does a great job of explaining what's happening on its support site: "The issue occurs when the Timeout Detection and Recovery feature available in Windows Vista and Windows 7 detects the graphics card has not responded within a predetermined period of time and reinitializes it with the Windows Display Driver Model (WDDM) to prevent the need to reboot."

Because your issue is specific to Access, that application might be responsible. Is it fully patched? If so, have you tried removing and adding it back? DirectX is a possible suspect as well; try reinstalling the latest version. You mentioned the drivers are up to date, but what about your BIOS? How about Windows?

Depending on how many times you've updated your Radeon drivers, and how thoroughly AMD's uninstall routine cleaned your system along the way, you could have older corrupted files interfering with the latest and greatest. The Doc has crushed a number of display bugs on well-used systems by running a utility called Display Driver Uninstaller. You'll have to run it at your own risk, and then update to the latest supported drivers from HP.

Once you work your way through symptoms related to software, it's time to consider hardware-based explanations. Have you ever cleaned out your notebook's air vents? Check the graphics processor's temperature using GPU-Z and the CPU with Core Temp. If they're too hot, it may be time to expose the dv7's innards.

Unfortunately, the worst-case scenario is that your graphics module, one of the SO-DIMMs, or some other component, is simply at the end of its life, in which case it could be time to start shopping for a new laptop. ⏻

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The Future of Solid-State Storage

It's taken a decade, but SSDs are finally delivering

by Jeremy Laird

SOLID-STATE STORAGE was once the final frontier. It's arrival would banish the last remaining mechanized throwback and deliver us into a brave new age of lagless, lightning-quick computing. Back in 2008, when the first affordable SSD rocked up, initial impressions were revelatory. But it quickly became clear solid-state storage wasn't quite the instant fix—it turned out to be the most complex component of all.

Whether it's different data types delivering differing performance, drive survival, or performance longevity, the more we learn, the more we recognize the limitations of earlier drives and realize how much potential there is. Fast forward to 2015 and today's SSDs are out-of-sight better than those laggy, stuttery, early-adopter drives. If you haven't already jumped to SSDs, we guarantee you'll be delighted when you do. It's now more affordable, too. Decently capacious drives with great performance can be had for under $150.

But we can also see just how much more there is to do. Frustratingly, there are a number of emerging technologies which promise dramatic improvements in SSDs that have either already arrived, but not yet delivered on their full promise, or remain tantalizingly out of reach.

What does that mean for you? If you already own a relatively up-to-date SSD, take it easy, you already have it pretty good. There's no hurry. If you haven't made the leap, the choice is trickier. You can either skip passing Go and collecting your $200, heading straight for our reviews of the best current drives, and experience a truly revelatory performance upgrade. Or you might want to find out about the next generation of drives and hold on that little bit longer. The choice is yours.

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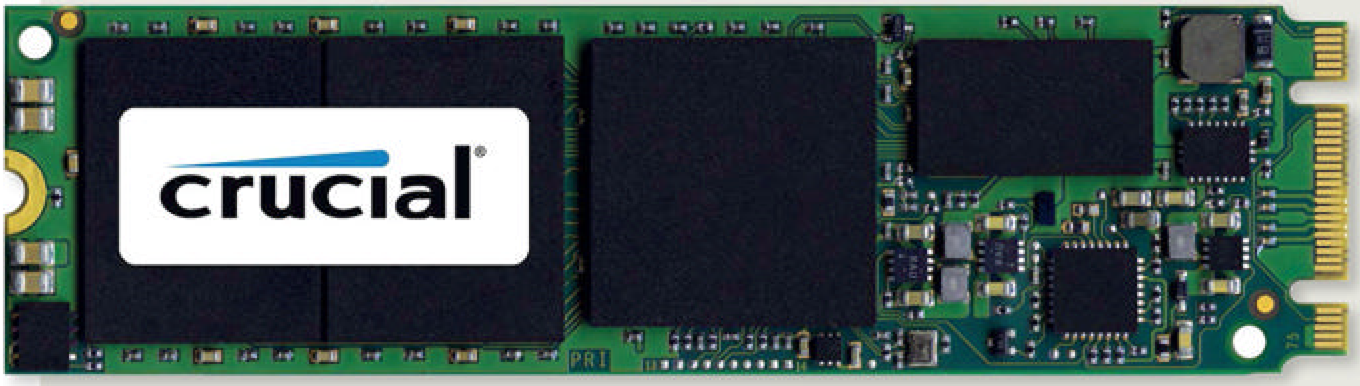

M.2 drives are the way to go, just be sure to get one with NVMe support.

IT'S 2015 and the better part of a decade since the first mainstream solid-state drives appeared. But somehow, it still feels a little like SSDs haven't quite arrived.

For sure, all PC components just keep getting better, keep getting faster, keep getting cheaper, and SSDs won't ever get to a point where they can no longer improve. But today's SSDs are wonderful things already. It's all too easy to forget just how sluggish magnetic hard drives could make a PC feel. Once you go solid, you don't ever want to go back.

The problem is that the PC as a platform wasn't really ready for solid-state drives when they first arrived. It still isn't fully optimized for them even now. But that's about to change. When it does, we reckon the SSD will truly come good. Unfortunately, that change is pretty complicated and it's probably not going to be cheap. Oh, and it won't be a case of simply picking up a drive with a fancy new feature and plugging it in.

But let's start at the beginning. The problem with SSDs, it turns out, isn't just the SSDs themselves. It's your PC. Or more specifically, the standard storage interface inside your PC, known as SATA. The problem with SATA is twofold. Firstly, it doesn't have enough pure, dumb bandwidth. It's limited to a mere 6Gb/s which translates into a real-world 600MB/s maximum.

Arguably just as problematic is that it doesn't know how to talk to SSDs properly. It uses a control protocol known as AHCI which was created for magnetic drives with spinning platters and never designed with SSDs in mind. And that means it introduces wholly unnecessary latencies into the read and write process in the context of SSDs.

PLAYING CATCH-UP

What we need is a new control protocol optimized for SSDs. And that's exactly what we're getting in the shape of NVMe or Non-Volatile Memory Express. NVMe isn't going to revolutionize the peak throughput you see. But what it should do is dramatically improve the random access performance SSDs can deliver. We're talking about all those little read and writes from your OS and apps, the ones that arguably have more impact on how responsive your PC feels moment to moment than peak sequential read and write performance.

Where things get really complicated, however, is the delivery vehicle for NVMe. You won't be surprised to learn it arrives alongside a new PCI Express-based storage interface, memorably known (not) as M.2. But it is confusing to learn that early M.2 solid-state drives have so far failed to support NVMe. Making matters even more complicated, there's an alternative new interface for SSDs, again with a PCI Express element, known as SATA Express, that weirdly looks stillborn. There's still the option of going with a straight PCI Express-based SSD too.

At first glance, then, the whole thing looks like a complete mess—a rats' nest of new interfaces, essential protocols not appearing in new drives, and technology seemingly dead on arrival. So how is it all going to shake out? What kit will you need and what will the benefits be when it all comes together? The easy bit is that you can ignore SATA Express. Compatible sockets are fairly commonplace on new mobos but SATA Express drives are nowhere to be seen and the SSD makers we've spoken to typically say they've zero plans to produce them. Laters!

The remaining two are really variations on the theme, that theme being the high bandwidth PCI Express interface. M.2 is a standard that closely resembles the existing mSATA interface for mobile PCs and involves bare circuit boards with exposed memory and controller chips. That's a little odd in the context of neatly boxed SATA drives. And it also means you're only typically getting a single M.2 slot on a new motherboard. But in practice, it does make sense for the medium term as you're likely to only need a single M.2 drive for your OS and apps, leaving legacy SATA ports as more than adequate for mass data storage on bigger, fatter, cheaper drives.

Crucial's MX100 may be a SATA drive, but it's still awesome value for money.

> The problem is that the PC as a platform wasn't really ready for solid-state drives when they first arrived.

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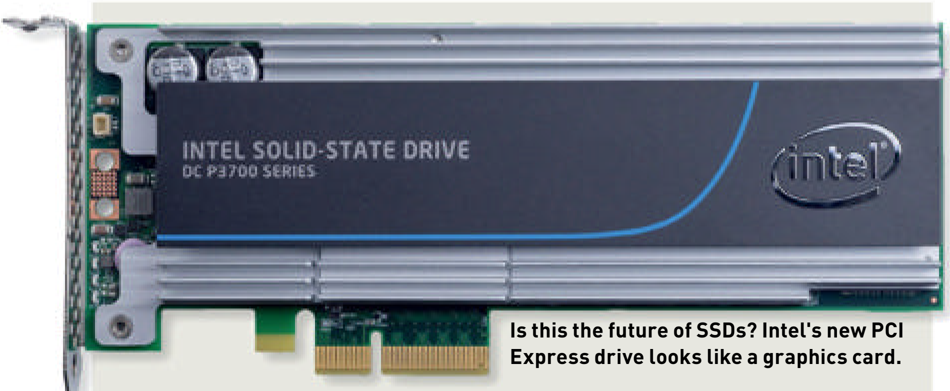
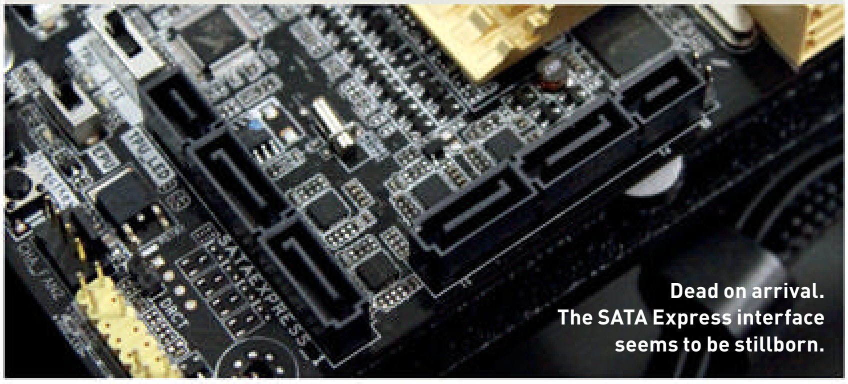


Is this the future of SSDs? Intel's new PCI Express drive looks like a graphics card.



Dead on arrival. The SATA Express interface seems to be stillborn.

Of course, the motherboard you have right now very probably doesn't have an M.2 slot. That means you'll either need a new mobo or a PCI Express adapter card. In theory, the latter should allow for M.2 drives on legacy motherboards. In practice your mileage will vary. Some online research regarding your own specific make and model of mobo is the order of the day.

EXPRESS DELIVERY

Assuming that's all sorted, the other major piece of the puzzle is making sure you've an NVMe-capable M.2 drive. We've had a fair few M.2 drives hit our test bench. But so far, none have support for NVMe. That's mostly because it's taking a little longer than anticipated for SSD controller chips with NVMe to ship to market. However, with the new Marvell 88SS1093 controller and others finally coming on stream, that's likely to change very soon. When it does, what can we expect in terms of performance?

Peak numbers will depend somewhat on configuration. Various PCI Express lane setups are possible, with x4 being the most we've seen referenced to so far. Whatever, what we're talking about is bandwidth in the low GB/s, the sort of numbers that were more typical for RAM just a few years ago, not hard drives. For us, however, the really intriguing numbers involve random access. Samsung has a new drive due out that's capable of 750,000 read IOPS. Admittedly this is an enterprise drive that's compatible with yet another interface standard known as SFF-8639 and which won't be coming to desktop PCs. But it hints at what NVMe drives will deliver. It's pretty much 10 times or an order of magnitude better than most of today's AHCI SATA drives. Yes, really.

While all this is going on, of course, the cost per GB of SSDs will keep dropping. Already, decent drives at what we think is the minimum desirable capacity—240 to 256GB—can be had for well under $150. Admittedly, the unstoppable march that is Moore's Law and the process of shrinking transistors seems to have slowed. However, new approaches, including 3D NAND or stacked memory chips (see "What's a 3D SSD?", right) should keep prices tumbling and capacities increasing for several years to come. It's all good.

Samsung's 850 Pro is the first SSD with 3D memory chips.

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What's a 3D SSD?

YOU'VE HEARD OF 3D GRAPHICS. But 3D SSDs? Oh, yes, they're a thing and they're coming. Actually, they're already here. Both Samsung's 850 Pro and 850 Evo drives use 3D NAND memory. But what does it mean?

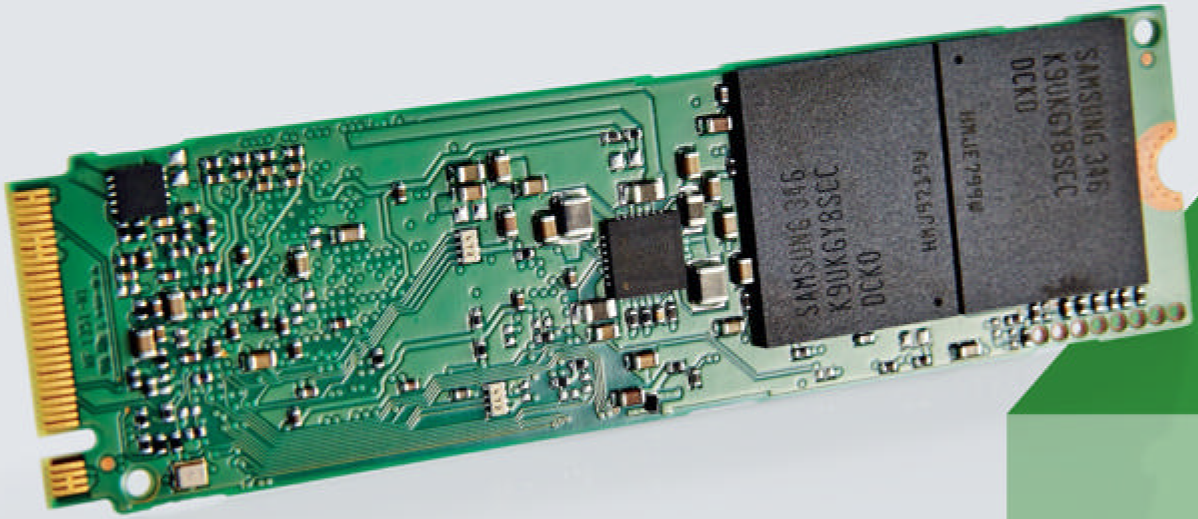
It means building chips in layers or 3D stacks of transistors rather than just a 2D plane, so you end up with loads more transistors per square millimeter. And that means greater memory density.

That's handy given chip makers are finding it ever harder to reduce the size of individual transistors, which is the traditional route to greater density and lower costs. The upshot is that Samsung is using some pretty old-school 40nm production technology for its 3D memory where 2D chips need to be sub-20nm for remotely comparable density.

What's more, there are further benefits. With each successive process shrink, NAND memory cells tend to be less robust. In other words, they can sustain fewer read/write cycles before dropping dead. So the brilliance of 3D NAND is that it reboots that vicious cycle to a degree.

Finally, 3D can also have performance benefits. In simple terms, you can have both horizontal and vertical interconnects and that creates more options. We're struggling to see a downside with 3D NAND memory, let's put it that way.

As ever, the full benefits haven't quite kicked in. Samsung's 3D NAND offerings aren't yet really any cheaper or much faster than the 2D alternatives. But 3D remains a critical enabler of both future performance increases and cost reductions. All the major NAND memory chip makers have plans to start cranking out 3D chips. Within a couple of years, it's likely most, if not all, SSDs will be 3D.



SAMSUNG XP941 512GB

Welcome to the wonderful world of M.2

TO PARAPHRASE DR. EVIL, is it too much to ask for an M.2 drive with frickin' laser beams, sorry NVMe support, attached to its head? No idea what we're talking about? Let's start at the beginning.

Solid-state drives were the final piece of the PC performance puzzle. Before they arrived, everything else was achieved with solid-state circuits. Central processing, system memory, graphics, the whole nine yards. But not mass storage of data.

No, that was still done using arcane magnetic platters rotating about a spindle and interrogated by read heads floating precariously above the platter surfaces. That made for slow going during certain tasks, most obviously collecting random bits of data from distant sections of the platters. It also makes conventional hard drives prone to failure due to the delicate moving components.

Of course in many ways those drives were, and remain, marvels of engineering. They were fundamentally a stop-gap idea waiting for a solution. That solution is solid-state storage where memory chips replace the magnetic platters. Suddenly, it doesn't matter where the data is stored on the drive, it's all equally accessible and, in the absence of moving parts with tight physical tolerances, you can knock things about to no ill effect. However, the arrival of the very first solid-state drives wasn't quite the technical triumph we'd been expecting. Early drives suffered from some pretty epic performance inconsistencies and it quickly became apparent there was much work to be done before SSDs fully delivered on the theoretical promise of solid-state storage.

Nearly a decade later and the waiting isn't quite over. Unfortunately, the new Samsung XP941 doesn't change that. Surprised? After all, this is one of the very first SSDs to be based on the new M.2 storage interface. M.2, of course, makes use of the PCI Express interconnect and that means masses of beautiful bandwidth. Where existing SATA drives are limited to 6Gb/s theoretical, which translates into about 550MB/s of real-world bandwidth, M.2's PCI Express tech means whole gigabytes per second are possible. The specifics vary according to how many PCI Express lanes are commandeered for storage, but however you slice it, we're talking about a huge leap forward.

For this particular drive, Samsung has configured four PCI Express lanes in 2.0 specification. On paper, PCI Express is good for 500MB/s per lane, so we're looking at a ceiling of around 2GB/s for a four-lane drive or roughly four times faster than SATA 6Gb/s. Of course, these are theoreticals and real-world performance will inevitably be lower. But it's not bad from a single generational leap, eh?

STORAGE HUNTER

In fact, it's so good that you're probably wondering what on earth could be stopping this slick little memory stick from achieving storage nirvana. To find out, we have to dig down into the technical details a little.

The XP941 is an 80mm M.2 drive, making it the second longest in a four-strong range

Samsung's XP941 lacks NVMe support, meaning many of M.2's benefits remain out of reach.

of standard M.2 form factors which also includes 42mm, 60mm, and 110mm. This isn't hugely significant for desktop PCs, as any motherboard with M.2 support should be able to cater for this drive physically. It's worth noting for laptop PCs, however, where limitations may exist.

Anyway, the 80mm form factor is significant in allowing for up to eight NAND memory packages and that, in turn, is what allows the XP941 to hit the 512GB capacity tested here. For the record, Samsung is using its own 64Gb 19nm Toggle-Mode 2.0 MLC NAND. Still, it remains a very neat little thing and, as jaded as we tend to be by even the most advanced kit, you have to marvel at the sheer storage capacity in such a small device. It's quite magical.

Whatever, the XP941 uses Samsung's first PCI Express SSD controller, the S4LN053X01. If that doesn't exactly trip off the tongue, there's not much of a story to help you remember it either. Details are hard to come by which is probably a function of the XP941's official status as an OEM product. In other words, it's mainly intended for PC manufacturers to put in prebuilt systems rather than aimed at inquisitive power users doing DIY configs.

The best we can do is guestimate based on this drive's specs that it's probably a PCI Express version of the MEX controller that Samsung fits to the 840 Evo and other SATA SSDs. As for what those specs specifically are, we're talking 1,170MB/s peak reads and 950MB/s writes. Random access, meanwhile, is rated at 122,000 IOPS for reads and 72,000 for writes.

Immediately, a few things become apparent. Firstly, this drive isn't capable of maxing out its four-lane PCI Express specification. How much that actually matters given that it's still claimed to be roughly twice as fast as any SATA drive is debatable. It's also worth remembering that M.2 ports on Intel H97 and Z97 boards are in any case limited to two lanes. A more unambiguous issue is those random access numbers. They're nothing special. And that, finally, brings us to Dr. Evil's head-mounted NVMe problem.

COMPRESSION SESSION

For all its PCI Express prowess, this drive lacks support for the new NVMe storage control protocol. It's an old school AHCI drive. And that means that like all other AHCI drives, it's not truly optimized for solid-state memory. The upshot of all this is fairly predictable. This drive flies in sequential workloads. It puts out about 1GB/s for both reads and writes and tears through our 30GB file transfer test faster than any other drive here by a mile. It also looks pretty clever in the PC Mark consistency stress test, losing out only to the SanDisk Extreme Pro by that metric.

On the other hand, it kicks out some extremely mediocre-looking results in the AS SSD 4K random benchmarks and likewise doesn't look remotely special in file compression workloads. All of which adds up to a pretty complicated way of explaining what was obvious from the get go. Without NVMe support, you're not getting the full M.2 experience.

It's also worth name-checking the caveats that apply to all M.2 drives. You'll need motherboard support and that's not a given. Only very recent mobos have native M.2 support and typically only cater for a single drive. Also, M.2 pinches PCI Express lanes. That can be a problem on the Intel LGA115x sockets with their limited PCI Express lane availability, especially if you're running multiple graphics cards.

That said, most motherboards should support M.2 via a cheap PCI Express adapter card, so the compatibility hurdle should be surmountable. It just may not be a case of simply hooking up the XP941 to your motherboard and letting rip. Finally, as we mentioned above, this is essentially an OEM product and that means it may not be too easy to find and source.

Ultimately, then, we're a tiny bit frustrated by the XP941. It's a big step forward in terms of raw bandwidth, but misses out on the bit we're really excited about, namely the big boost in random access performance promised by the new NVMe protocol. And that's something we really want to see on any M.2 drive. It's not like we're demanding sharks with frickin' laser beams on their heads, is it?

VERDICT
7

Samsung XP941 512GB

➕ **XP** Speedy sequential performance; consistent; supports PCI Express x4.

➖ **MILLENIUM** Not cheap; doesn't do NVMe.

$510, www.samsung.com

SAMSUNG
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SAMSUNG 850 EVO 500GB

3D memory goes mainstream

WITHOUT GIVING AWAY TOO MUCH, too soon, you may have noticed that both of our showcase SSDs this issue hail from the same outfit, namely Samsung. Without doubt, the Korean giant dominates the market for solid-state drives. That applies in terms of sheer number and presence, *plus* in terms of technical innovation. And it's the latter that qualifies the 850 Evo for special attention, though that doesn't mean it's doing something absolutely new or that it's necessarily a winner. Still, it's all a bit galling when you consider Samsung is also dominant in the smartphone market. And HDTVs. And just about any other area of consumer electronics you care to mention. Resistance, it seems, is futile.

Not that it's terribly surprising to find big players dominating a technology like solid-state drives. At their core, SSDs depend upon memory chips created courtesy of some of the most advanced technology in the world. For advanced, read expensive. It now costs many billions of dollars to build a factory for memory chips and there are very few companies who can stump up that kind of cash. Consolidation down to a few key players is inevitable.

However, as dominant as Samsung is, it's not actually unchallenged in the SSD market. While only a handful of companies make memory chips, there are a fair few who knock out controller chipsets and even more who put controllers together with memory chips to create drives. That means Samsung's innovations can be largely seen as adding to healthy competition rather than tools of competitive oppression. For now, at least.

Whatever, the big news with the Samsung 850 Evo is its use of 3D memory chips. It's not actually the first time we've seen 3D memory in an SSD, known as V-NAND or vertical NAND in Samsung speak. That distinction goes to its Samsung sibling, the 850 Pro. Yeah, it was always going to be another Samsung drive. But the 850 Evo brings 3D memory to a more mainstream part of the market and signals what looks like being a shift in memory tech that will eventually take over every SSD.

LAYERING UP

The future, then, is 3D memory. But what does that mean? In simple terms, we're talking about memory chips that go up in layers as well as across in terms of the pattern of the circuit. Say what? Haven't integrated circuits always been built up in layers? That's nothing new, is it?

Actually, yes. Previously, the layers in a chip were all about providing connectivity between the thousands and then millions and latterly billions of transistors. That's such a complex job, it had to be achieved using multiple layers. But the network of the critical component—those transistors—was essentially laid out on a 2D plane. Chips had a single layer of transistors.

The 850 Evo might boast exciting 3D memory, but it's still stuck in the land of the AHCI protocol.

With 3D memory, the big innovation is multiple layers of transistors. As we're talking memory chips, that effectively means multiple layers of memory cells. Immediately, the impact of that is obvious. Two layers of cells gives you twice the memory capacity for any given area of chip, albeit at the cost of increased thickness. But it's easy to see how memory capacity suddenly skyrockets when you start to build up multiple layers of cells. As it happens, Samsung has also upgraded its V-NAND from two bits per cell to three bits per cell for the 850 Evo, thereby upping capacity even further.

That's important for all kinds of reasons. For starters, the chip industry is having increasing problems keeping Moore's Law on track. Moore's Law says the chip industry will squeeze twice the number of transistors into a given area of chip every two years. In other words, it's a doubling of transistor density that results in the exponential growth of transistor counts and therefore processing power and memory capacity over time.

Eventually, we'll arrive at transistors made of one or two atoms and the fun will stop. We're not far off that today, so a new approach is needed if we're to keep increasing memory capacity. The other big upside is also related to the manufacturing processes used to create chips. As transistors and in turn memory cells shrink ever smaller, they become less robust. In other words, they can sustain fewer read and write cycles before they fail.

The same applies to memory cells with the capacity to store multiple bits of data. As you go from single-bit to two-bit and three-bit cells, robustness tends to fall off. All of which means that the endurance of flash memory has been getting worse and worse as capacities have increased.

Introduce 3D memory, however, and you can wind back the clock a bit on that problem. That's exactly what Samsung has done with its own 3D NAND memory. Because it's composed of 32 layers of memory cells, Samsung can achieve excellent memory density without the latest manufacturing tech. The 850 Evo's memory chips are 40nm items but still achieve 128Gb per chip. That's several generations behind its cutting-edge 19nm 2D chips.

Oh, and as if that wasn't enough, the vertical connections between the layers of memory cells, known in tech speak as through-silicon vias or TSVs, also help boost bandwidth inside the chip and therefore overall memory performance. So that's more storage, increased endurance, and better performance. Yup, 3D NAND looks like being all things to all PCs.

NOT FAR ENOUGH

In capacities up to and including this 500GB model, the 850 Evo also gets Samsung's latest MGX SATA SSD controller. So there's an awful lot of newness all round. But does all this theoretical hotness actually make the new 850 Evo any better in the real world? Unfortunately, there's an immediate and very obvious problem. This is a conventional SATA drive suffering the AHCI protocol and a modest 6Gb/s bandwidth ceiling. It's not a fancy new M.2 drive with oodles of PCI Express-powered bandwidth and SSD-optimized NVMe gubbins. Oh dear.

It's no surprise, then, to find our test results look largely pedestrian. So, that's 500-odd MB/s for peak sequential performance and healthy but ultimately unremarkable 4K random numbers. The same goes for our file transfer and compression tests. The 850 Evo doesn't do anything terribly special. Nor does it set the world alight for performance consistency. We should also point out that Samsung's RAPID mode feature is pretty useless in the real world. On paper, it uses your system memory as a super-fast drive cache. In practice, it only delivers really tangible results in synthetic tests.

All of which means the upsides of the 850 Evo's flashy 3D NAND memory end up feeling a little theoretical. That's not to say the Evo is in any way a bad solid-state drive. Taken in context—as a 500GB SATA drive at this price point—it's definitely still highly competitive. It's simply not the game changer we'd been hoping for.

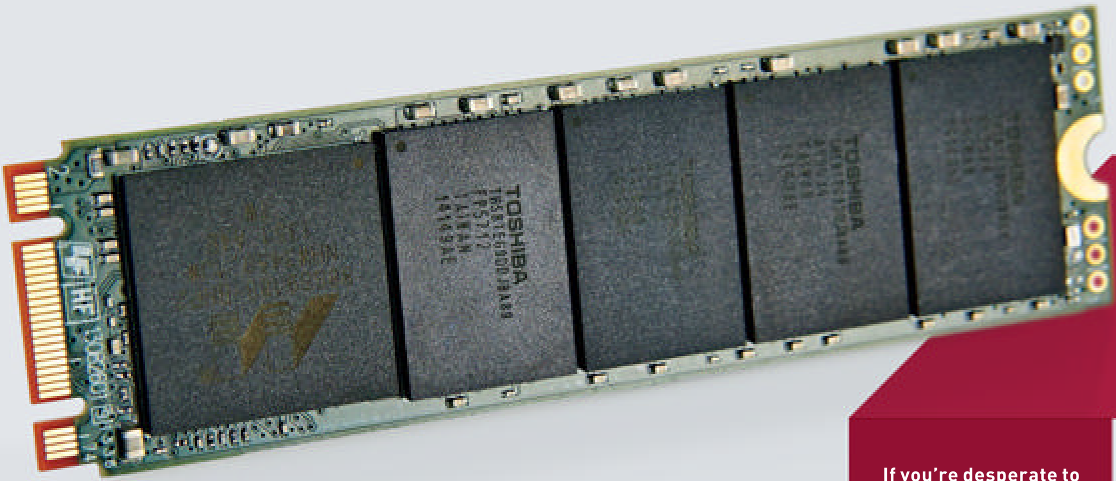
VERDICT 7

Samsung 850 Evo 500GB

AVATAR Good all-round spec; longevity bodes well.

JAWS 3-D Limited by SATA interface; M.2 drives are faster.

$230, www.samsung.com



PLEXTOR M6E 512GB

M.2 done wrong

If you're desperate to get an early M.2 drive, best avoid this over-priced Plextor.

TO EARLY ADOPT OR NOT? That is the question. At least, it's the question you'd better have in mind when considering the new Plextor M6e. Because it most definitely ain't the finished M.2 article.

All this M.2 and PCI Express stuff is still quite new and certainly a little confusing, so let's recap. M.2 is the new PCI Express-based storage interface that's taking over planet Earth. Well, it's taking over the little bit of planet Earth that is PC data storage. In the process it's replacing the venerable SATA interconnect.

That's overdue for several reasons. Firstly, SATA development has crept along at what you might call a rather stately pace, requiring a new standard for each and every speed boost. Meanwhile, the underlying performance of solid-state drives has grown fast and thumped firmly into the 6Gb/s ceiling of SATA. Make PCI Express the basis of your storage connectivity and you can dial up more bandwidth merely by adding more links. Wahey.

What's more, the control protocol that comes with SATA, known as AHCI, is a clunky old thing designed for irritable old magnetic drives. And it simply isn't any good at talking to sleek, modern SSDs and their zingy NAND memory chips. For that you want NVMe and its low-latency cleverness. Except this M.2 drive from Plextor doesn't have NVMe support, which is where the early adopter angle comes in. As we'll see, there are still benefits of an M.2 drive like this that makes do with AHCI, but it's almost certainly not nearly as good as the NVMe M.2 drives that are due later this year.

ROLLING IN CACHE

We also can't help but notice that the M6e sports a mere two-lane PCI Express interface. Now it just so happens that Intel limited bandwidth to its native M.2 slots for the H97 and Z97 chipsets to two lanes. So you could argue that's academic for most right now. But then you could also use this SSD in a PCI Express adapter card to sidestep that limitation.

What's more, there's the Marvell 9183 controller onboard, which bodes well enough, and for this 512GB version you also get a full 1GB of DDR cache memory and a decent five-year warranty. Not bad. Nor are the M6e's test results. It is unambiguously, undeniably quicker than any SATA drive in sequential work loads, be that synthetic or real world. On the synthetic side, you're looking at peak data transfer in and around 700MB/s in both directions.

Back in the real world, it zaps our 30GB file transfer test in two minutes and 46 seconds. Most SATA drives take 30 to 40 seconds longer. That, unfortunately, is where the good news ends. No doubt thanks to a controller chipset that doesn't talk the new NVMe lingo, 4K random access performance is pretty poor, even by SATA standards. Likewise, it's dead last in our performance endurance test and returns some seriously nasty looking numbers in the degradation part of that test. Just to add insult to injury, Samsung's M.2 alternative, the XP941, tears the Plextor a new one when it comes to peak sequential performance, cracking the 1GB/s barrier. It also does very well in the performance degradation test. So there's little doubt which drive is the pick of the early M.2 movers.

Of course, the M6e is also a proper retail product, so a little easier to find. But as we go to press it's probably not much, if any, cheaper than the Samsung. If you are absolutely committed to going with a pre-NVMe M.2 drive, it's hard to make the case for the M6e over the Samsung alternative.

VERDICT 6

Plextor M6e 512GB

⊞ **EARLY BIRD** Faster peak performance than SATA drives; five-year warranty.

⊟ **EARLY EXIT** Unimpressive for an M.2 drive; very expensive.

$470, www.plextor.com

SAMSUNG 850 PRO 512GB

The king is dead

SAMSUNG
Solid State Drive

AH, HOW QUICKLY the all-conquering tech hotness of yesterday becomes today's object lesson in instant obsolescence. Just a few months ago, Samsung wheeled out its new 850 Pro SSD and all were strewn asunder. With its fancy new 3D NAND memory and world-beating performance, the 850 Pro was the solid-state weapon of choice. This was the SATA SSD you had to buy. Assuming you could afford the price premium, that is.

But suddenly, the 850 Pro is looking a lot less clever. For starters, drives based on the new M.2 interface, including Samsung's very own XP941, are popping up and bringing with them unprecedented levels of PCI Express storage performance. There's no getting round it, they simply annihilate any mere SATA drive like the 850 Pro for peak throughput.

That performance gap is only going to get worse very soon when M.2 drives with NVMe support appear and take 4K random access to all new heights. And while we're talking fratricide, Samsung has also released the 850 Evo with revised TLC 3D NAND memory. So the 850 Pro is looking old hat by pretty much every metric. It's not even unique in having 3D memory chips any longer.

And as if all that wasn't bad enough, the 850 Pro must contend with SanDisk's Extreme Pro, which can teach it a thing or two about performance consistency. Ouch. To be clear, this remains a very rapid drive by SATA SSD standards, but in the battle of the "Pro" drives, SanDisk wins out.

It's got some pretty hot specifications, including that 40nm 3D NAND memory that promises outstanding long term reliability. Samsung rates this thing at 150TB for overall endurance, which is epic. But things are moving fast. That fact, plus the 850 Pro's lofty, going on debilitating, pricing makes what was recently a very desirable drive surprisingly tricky to recommend.

So recently the must-have SSD, the 850 Pro is already struggling to keep up with the pace.

VERDICT
7

Samsung 850 Pro 512GB

⊞ **LORDIN' IT** One of the best SATA drives around; excellent endurance rating.

⊟ **PAST IT** M.2 drives are much faster; suddenly looks old and expensive.

$340, www.samsung.com

KINGSTON HYPERX 3K 480GB

Left behind by Father Time

HYPERX
Kingston

"YOU BETTER START SWIMMIN', or you'll sink like a stone, for the times they are a-changin'." Or to put it another way, get with the program, dude! Things are shifting fast in the SSD market and drives like the elderly HyperX 3K are being left for dead.

It's not all bad news. The "3K" in Kingston's moniker refers to the number of program/erase, or P/E cycles, its memory cells support. At launch, 3,000 P/E wasn't great. But as memory cells have shrunk, so has their endurance. Today, the 3K rating delivered by the HyperX's 25nm Intel NAND memory isn't too shabby. Drives with mere 1.5K and 1K P/E cycles are on the market.

But elsewhere, time hasn't been kind. It's based on the SandForce SF-2281 controller chipset which once ruled the market but is now almost end-of-life. The 2281 now looks odd in that this 480GB drive actually offers worse performance than 120GB and 240GB variants of the HyperX 3K. That's true for both 4K random access and sequential throughput. Usually, smaller drives lag behind.

As for actual tested performance, the 3K doesn't look too hot. The traditional incompressible data limitation that SandForce controllers have suffered from makes an appearance and ensures the slowest sequential bandwidth of all our SSDs this month in the AS SSD benchmark. The 263MB/s for sequential incompressible writes is a very ugly number. The 4K randoms aren't that great, either; 20MB/s for 4K random writes is little more than one quarter of what we now expect.

Then there's performance consistency over time with heavy usage. It's certainly consistent, but it's consistently low. All of which makes for a rather unappealing SSD. It's not actually disastrous. It's just been left behind by old Father Time.

Poor benchmarks and outdated tech make the HyperX the worst of our tested SSDs.

VERDICT
5

Kingston HyperX 3K 480GB

⊞ **HYPERSPEED** It used to be a contender; decent P/E cycles.

⊟ **FIRST GEAR** Slow out of the box; even slower with sustained use.

$275, www.kingston.com

SanDisk
Extreme PRO
Solid State Drive
SanDisk

The unpretentious Duracell Bunny of SSDs gets our gong for best drive.

SANDISK EXTREME PRO 480GB

The price of consistency

KEEP IT SIMPLE, STUPID. Even if that means making everything, well, stupid. That's pretty much how the mass marketing of most consumer goods works. It explains why the processor industry disappeared down the rabbit hole chasing megahertz in the late 1990s. More megahertz must be better. It's a simple and effective sales pitch. Likewise, the burgeoning CPU core counts in smartphones. Never mind that most software and apps on mobile devices aren't multithreaded, that phone has eight cores. It must be totally awesome.

Apply that same logic to everything from megapixels in cameras to milliseconds in LCD panels and you've got the sales pitch all sown up. In that context, we fear for SanDisk's Extreme Pro. It may not be cynical enough. SanDisk seems to have concentrated on producing a drive that gives a great experience, rather than merely ticking boxes and chasing specs.

For starters, this is a SATA 6Gb/s drive, not a fancy new M.2 model with NVMe and PCI Express-powered bandwidth. It won't turn any heads with claimed read and write performance of 550MB/s and 515MB/s respectively. OK, the 4K IOPS numbers don't look half bad at around 100,000 each. Until you remember drives with NVMe support are due to hit the million mark.

On paper, then, the Extreme Pro looks routine. Until you clock the 10-year warranty. Then there's the nuanced metric of drive performance that is consistency. Pretty much all SSDs fly out of the box. The rate at which performance falls off with use, however, is much more variable and has a big impact on how good an experience you actually get. But again, it's also an extremely unsexy measure of performance.

PLAYING THE LONG GAME

Anyway, SanDisk claims the Extreme Pro is more consistent than the usual suspects including Samsung's 850 Pro and the Crucial M550. How so? The basic specs don't give much away. There's SanDisk's 19nm MLC NAND memory and a slightly crusty Marvell 88SS9187 controller. OK, SanDisk has provided a large 32GB slab of spare NAND memory to step in as cells die off and enable that 10-year warranty, albeit at the cost of overall usable capacity. And its nCache tech does some clever things courtesy of using a small section of usable memory in high-performance SLC mode.

But in the end, it's stuff you can't easily point to that makes the difference, namely SanDisk's firmware. A quick glance at our benchmarks wouldn't have you sprinting out to pick up an Extreme Pro. Sure, it puts out very competitive numbers for a 6Gb/s SATA drive, but it's also one hell of a lot more expensive. With one critical exception. The Extreme Pro returned the best performance consistency numbers we've ever seen.

This drive just keeps on trucking, no matter how much you throw at it. In the real world, then, the Extreme Pro will be tangibly faster than just about any other SATA 6Gb/s SSD you can currently buy. Because it will still be performing near its peak while other drives have lost their edge. Whether that's worth the price is another question, especially in the context of the slightly stingy 480GB usable capacity, not to mention the imminent influx of M.2 NVMe drives. If it weren't for the latter, we'd heartily recommend the Extreme Pro. But they are coming and that makes spending this much on a SATA drive a bit of a stretch.

VERDICT
8

SanDisk Extreme Pro 480GB

+ **MARATHON MAN** Exceptional performance consistency; 10-year warranty.

− **ONE-HIT WONDER** M.2 performance peak higher; not cheap for a SATA drive.

$260, www.sandisk.com

CRUCIAL MX100 512GB

The SSD that just won't die

ONE DAY THE CRUCIAL MX100 will hang up its spurs. It'll retire from the solid-state storage game and get some well deserved rest. But that day hasn't quite come. Incredibly for a drive that has never really been a world beater by any single metric, it remains relevant. Just.

A lot of that is down to cost. For an SSD from one of the really big noises in solid-state storage, this thing is filthy cheap. It's probably not the cheapest drive you can get in the 500GB segment. But it's very appealing given Crucial's reputation for producing decently reliable drives.

It's also worth noting that at this capacity, the MX100's Marvell controller actually comes good. The 256GB and smaller variants of the MX100 drop off when it comes to sequential read performance due to the way the Marvell controller manages its memory channels. But with all the channels populated in this 512GB version, you get peak performance over 500MB/s for both reads and writes.

That's close enough to the best SATA drives that it hardly matters. Its 4K random performance is remarkably non-shabby too, with writes over 100MB/s and tolerable 24MB/s reads. It puts in a very decent effort in our 30GB file transfer test as well, beating even the mighty Samsung 850 Pro.

At this point, you're probably wondering why you'd bother paying more and we couldn't really disagree. The only real catch is some patchy performance in our performance consistency tests. It's not as awful as Plextor's M6e drive. But it's bad enough to remind you that you do, in the end, get what you pay for.

Of course, that's always been true of the MX100 and until M.2 drives with NVMe support finally arrive, you can make a pretty good argument for grabbing one of these on the cheap and waiting for the next really big jump in storage performance to arrive.

The MX100 would make a good, cheap stopgap if you're waiting for an M.2 drive with NVMe support.

VERDICT 8

Crucial MX100 512GB

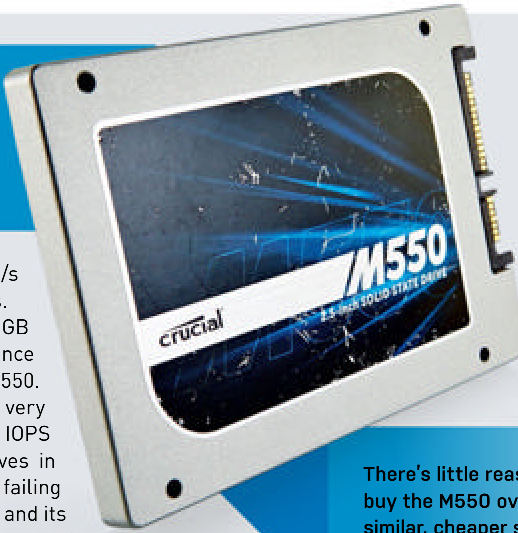
HIGHLANDER Silly cheap; decent all-round performance.

HIGHLANDER II Poor consistency; SATA is yesterday's news.

$175, www.crucial.com

CRUCIAL M550 512GB

Big, but not that clever



WE'VE ALWAYS BEEN BIG FANS of Crucial's MX100. So a similar but upgraded drive from the same brand ought to be a no brainer, right? If only things were so simple.

But let's not get ahead of ourselves. First let's take a look at what separates this range-topping M550 from Crucial's more prosaic MX100. It's not the controller chipset, as both drives tote the Marvell 88SS9189 chip. Of course, that doesn't mean you're getting the same quality of firmware from each drive and we've long known that firmware is at least as important and possibly more so than the controller chip.

As for flash memory, the MX100 uses 16nm chips to the M550's 20nm items, suggesting the latter should last longer. That said, Crucial applies the very same 72TB endurance rating or three-year warranty to both drives. As for performance, that's a wash as well when it comes to peak sequential transfers, with both of the drives hitting a claimed 550MB/s for reads and 500MB/s for writes.

Admittedly, the smaller 256GB MX100 loses write performance compared to the 256GB M550. But that's academic. There's very little in it regards claimed 4K IOPS capability either. And so it proves in our benchmarks with the M550 failing to put clear water between itself and its cheaper sibling by pretty much any metric.

In fact, the MX100 turned out slightly faster for both 4K random reads and writes. D'oh! Critically, the unflattering comparison extends to performance consistency. Both drives are awfully similar. For the MX100, that's fine. It's very cheap. For the pricier M550, it's a cap to the head. We doubt paying extra for the M550 would make any difference to the performance or reliability of your PC. It's a decent enough drive, but that's a damning conclusion.

There's little reason to buy the M550 over its similar, cheaper sibling, the MX100.

VERDICT 6

Crucial M550 512GB

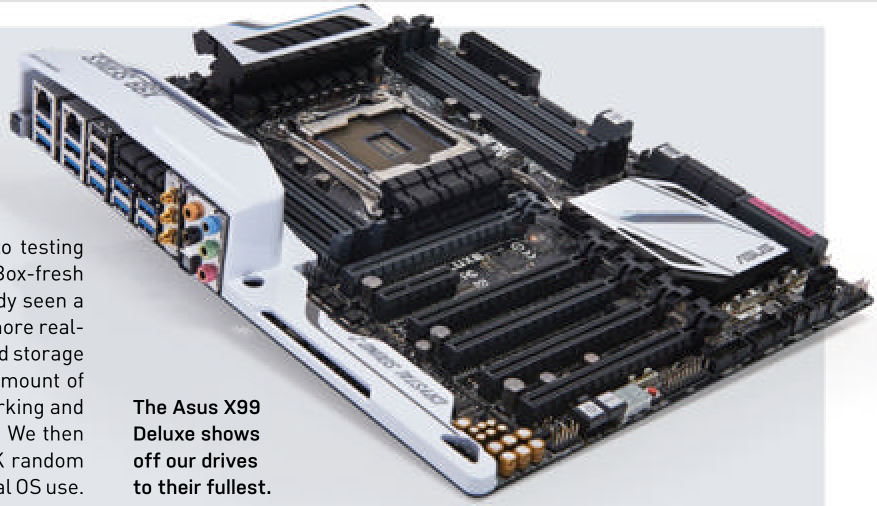
CRUCIAL Tolerable all-rounder performance; decent endurance rating.

POINTLESS Poor performance consistency; expensive against the MX100.

$260, www.crucial.com

HOW WE TESTED

The most important thing to nail down when it comes to testing SSDs is to ensure you're testing from a level playing field. Box-fresh drives often perform better than drives which have already seen a fair bit of use. To make sure all our drives are tested in a more real-world state, we ran each drive through PCMark8's extended storage consistency test. This hammers each drive with a huge amount of data, at once putting them in a reliable state for benchmarking and delivering a snapshot of how they perform under duress. We then ran our real-world and synthetic benchmarks and the 4K random test to emulate the small file transfers that make up general OS use.



The Asus X99 Deluxe shows off our drives to their fullest.

BENCHMARKS

Testing	Samsung XP941 512GB	Samsung 850 EVO 500GB	Plextor M6e 512GB	Samsung 850 Pro 512GB	Kingston HyperX 3K 480GB	SanDisk Extreme Pro 480GB	Crucial MX100 512GB	Crucial M550 512GB
ATTO Peak Read/Write Speed (MB/s)	**1,060/997**	553/533	733/690	561/532	542/517	554/520	553/506	560/510
AS SSD Average Read/Write Speed (MB/s)	**1,055/885**	494/485	649/645	528/500	484/263	506/474	499/474	504/463
AS SSD 4K Read/Write Speed (MB/s)	23/49	**36/108**	27/76	**37/107**	22/20	30/103	24/106	22/92
5GB File Compression (seconds)	73	74	72	73	76	**71**	74	79
30GB Steam Folder Transfer (seconds)	**132**	208	166	169	205	191	191	183
PCMark 8 Consistency (index score)	4,849	4,474	3,921	4,751	4,676	**4,929**	4,291	4,340

Best scores are bolded. All our SSDs were tested on an Asus X99 Deluxe motherboard with an Intel Core i7-5960X CPU, 16GB DDR4 memory @ 2,133MHz, and an Nvidia GTX 980 reference card.

SPECIFICATIONS

	Samsung XP941	Samsung 850 EVO	Plextor M6e	Samsung 850 Pro	Kingston HyperX 3K	SanDisk Extreme Pro 480GB	Crucial MX100	Crucial M550
Manufacturer	Samsung	Samsung	Plextor	Samsung	Kingston	SanDisk	Crucial	Crucial
Price	$510	$230	$470	$340	$275	$260	$175	$260
Website	www.samsung.com	www.samsung.com	www.plextor.com	www.samsung.com	www.kingston.com	www.sandisk.com	www.crucial.com	www.crucial.com
Capacity	512GB	500GB	512GB	512GB	480GB	480GB	512GB	512GB
Memory Controller	Samsung S4LN053X01	Samsung MGX	Marvell 9183	Samsung MEX	SandForce SF-2281	Marvell 9187	Marvell 9189	Marvell 9189
Memory	Samsung 19nm MLC	Samsung 40nm 3bit MLC (V-NAND)	Toshiba 19nm MLC	Samsung 40nm 2bit MLC (V-NAND)	Intel 25nm MLC	SanDisk 19nm MLC	Micron 16nm MLC	Micron 20nm MLC
Cache	512MB	512MB	1GB	512GB	N/A	1GB	512MB	512GB
Score (10/10)	7	7	6	7	5	8	8	6

Best SSD in blue.

And the winner is...

SANDISK EXTREME PRO 480GB

FIRST THE GOOD NEWS. None of these drives are ambulance-chasing disasters. With prices kicking off as low as $175, a decent 500GB SSD is now affordable. That's important because 500GB allows for a very generous library of installed games and other apps alongside your operating system. The bad news is that the SSD market is currently in transition. So while there are no absolute horrors, nor is there a single drive that totally gives us the hots.

The problem is that the promise of M.2—the überfast PCI Express-based storage interface—hasn't been fully realized. That won't happen until M.2 drives that also support the new NVMe control protocol arrive. Until then, we can see how good things are *going* to be. And that makes existing drives, be they older SATA drives or early M.2 items, a bit short on appeal.

That said, everything is relative and if you're either still using a magnetic hard drive or suffering a stuttering early SSD, any of these drives will be a great upgrade. So which should you go for? Not the Kingston HyperX 3K. Of all the solid-state drives here, it's the one that feels most dated thanks to its SandForce controller and patchy performance. If it was exceptionally cheap, that would make a difference. But it's not, so it doesn't.

Next through the window of dismissal in unceremonious fashion is, surprisingly, an M.2 drive. Yup, the Plextor M6e with its hot new M.2 interface is a goner. It's quick compared to SATA drives for peak performance, but it's pricey and very disappointing for an M.2 drive. Then there's the Crucial M550. Frankly, it's difficult to know why it still exists. It's really no better than Crucial's own MX100 and yet much more expensive. Goodbye. If those are the drives we'd suggest you avoid, from here on in we're talking about SSDs that really are worth owning.

CHAMPION DRIVES

Samsung's 850 Pro is one hell of a SATA SSD, but it also comes at one hell of a price. So it can't actually win. Samsung's 850 Evo is an appealing effort, too. The 40nm 3D NAND bodes well for long-term reliability and it's quick by most metrics. The price isn't bad, either. Problem is, there's another drive here that's only a little pricier but offers far better performance consistency. Hold that thought.

Now we're into the podium positions and it's as much about picking the right drive for your needs as saying which is the best. But we need a finishing order. The bronze medal therefore goes to our old favorite the MX100. Yes, it suffers from patchy performance consistency, but it's wonderfully affordable for a 500GB SSD. It's a decent drive at a great price.

In second spot is the Samsung XP941. There's an air of early adoption about this OEM M.2 drive. It's super quick in some tests and yet still not as fast as we're expecting from M.2 SSDs in the coming months. It's expensive, too.

All of which means our winner is the SanDisk Extreme Pro. It's a SATA drive, obviously, so won't help if you're looking for an M.2 item. But it's by far the most consistent drive we've ever seen in terms of sustained performance. It's reasonably priced. And it's the SSD we'd most like to have in our PCs today.

NEXT-GEN TECH PREVIEW

With so much new kit to cram into 12 months, it's going to be one jam-packed techgasm of a year. Here are some of the highlights... **by Dave James**

Intel GbE LAN
UEFI DualBIOS

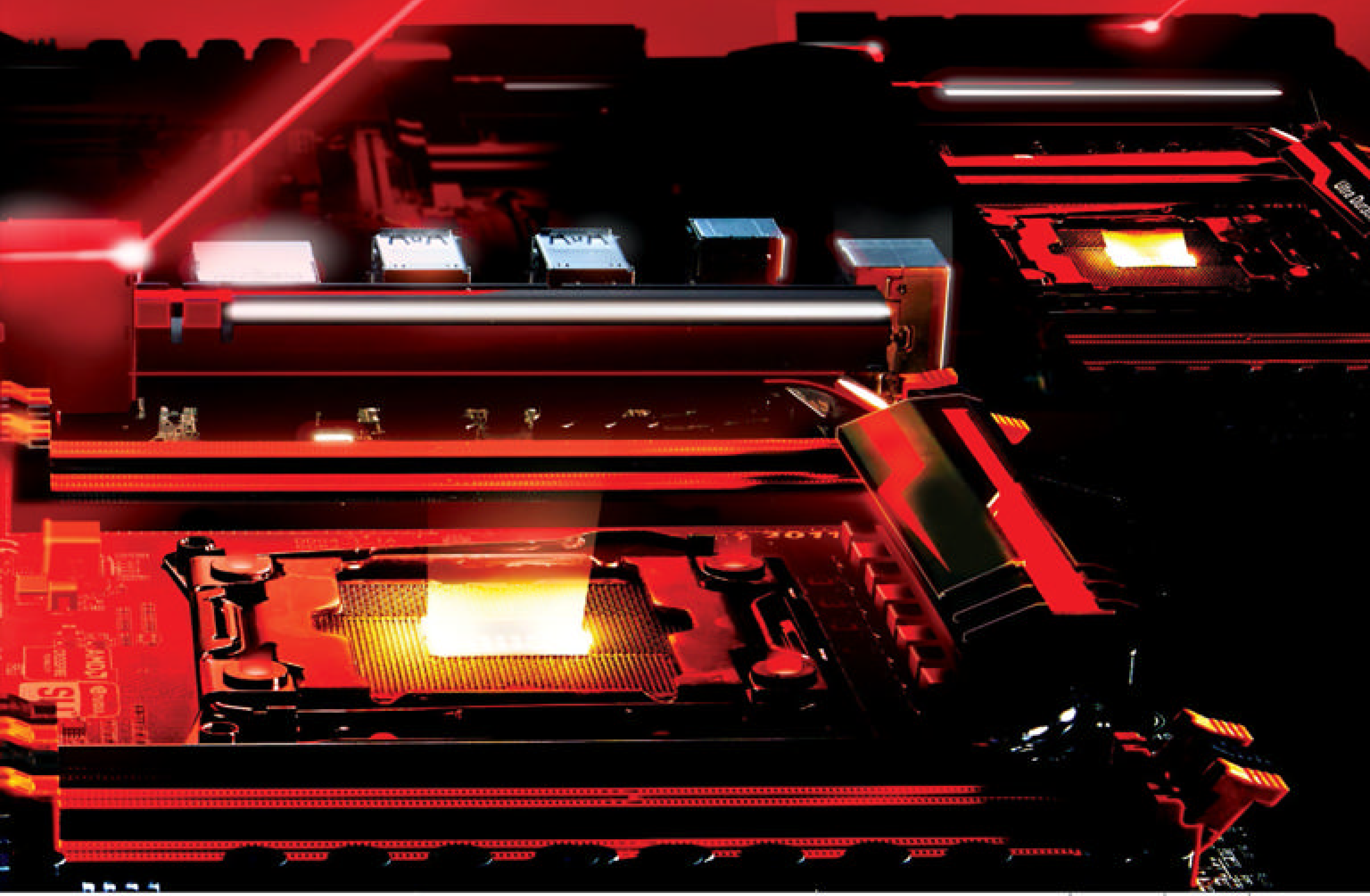
Have you seen the price of crystal balls recently? They're super-expensive. Obviously fortune tellers have vast sums of money from their numerous lottery wins to call on, but us tech journalists don't have such resources to fall back on. No, we need to do research, ask questions, and investigate, all in order to figure out what's going to happen over the next 12 months. Not like those feckless fairground rich-kid psychics…

On the surface of it though, predicting what's coming up for the rabid technorati in 2015 should be pretty simple. There'll be new, quicker processors, faster graphics cards, laptops with longer-lasting batteries, and screens with more pixels than stars in the night sky. Digging into the specifics though is a little trickier, and more difficult still is to figure out the motivations and unspoken intimations behind what's going on with new releases.

There are also areas where we may not have expected much progress, let alone anything new or even interesting. Things like the sudden resurgence of virtual reality as a tangible product, evolving from being purely about a single tantalizing device into an increasingly crowded future marketplace. We're also seeing tech being born entirely from burgeoning past-times, like game streaming, coming to the fore, too. So while there will certainly be the usual suspects releasing iterative updates of their previous generations, there will also be a huge amount of innovation coming over the next year.

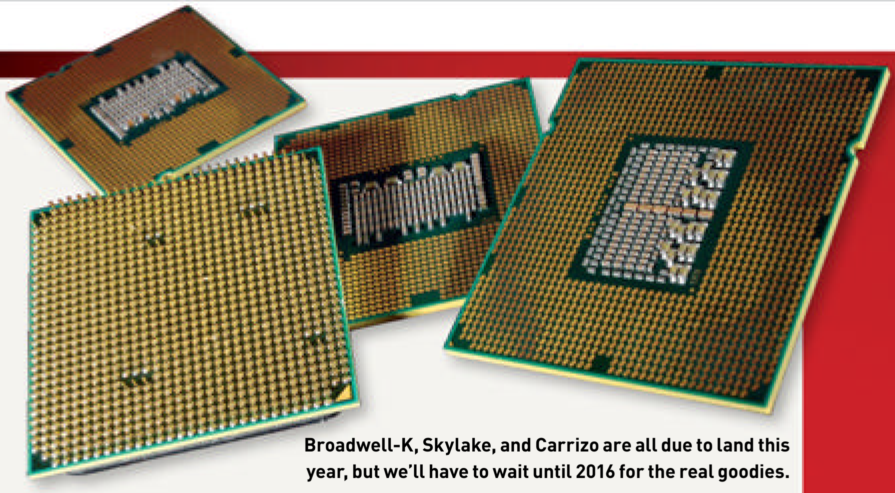
And this is all vital stuff for us PC folk. We're the fixers, the upgraders, and we need to know when, and indeed if, we should be looking for that next major PC update. Should we stick with our current CPU for the next 12 months, for example? Install some new release now or wait for something better to arrive in the summer? Picking the right time to upgrade is a perennial struggle for the PC builder—there's always something new on the near horizon—but fearlessly spending big on the "new thing" can be a huge waste when the "newer thing" comes out only a month later.

So what are we waiting for? Let's dive headfirst into 2015 and figure out what's going to be on the wishlist for this year's perfect PC.



INTEL PROCESSORS

The silicon giant has got a chip-packed year on its hands. Maybe a little too tightly packed...



Broadwell-K, Skylake, and Carrizo are all due to land this year, but we'll have to wait until 2016 for the real goodies.

THE NEXT 12 MONTHS are going to be big for Intel. There are two huge desktop launches coming this year, one a process shrink down to 14nm with the socketed Broadwell chips and the next a new microarchitecture to take that die-shrink even further with Skylake. Having two new processor generations, the fifth- and sixth-gen core architectures, both arriving in 2015 is a bit odd, and shows how delayed the Broadwell die-shrink has been in the final reckoning.

Intel though will tell you it launched Broadwell in 2014, but for us the Core M simply isn't the Broadwell processor we've been waiting for. No, Broadwell proper isn't due to arrive until "mid-2015" according to a presentation we had around the release of the latest low-power mobile U-series chips. So we're waiting until the summer for both the quad-core 14nm laptop chips and the K-series socketed desktop parts to go in our waiting Z97 motherboards.

But, and this is where things get complicated, we're also expecting Skylake processors to arrive in the summer. Speaking with motherboard manufacturers, they've been prepping to release their new Skylake mobos, the Z170s, at Computex in June. These aren't backwards compatible as they're pinned specifically for Skylake processors and some will be rocking DDR4 compatibility.

Double trouble

So yes, this all means we ought to be getting sixth-gen desktop chips around the same time as Broadwell-K parts go on sale. Sadly, that points to overclockable K-series Skylake chips being held back until next year, along with the beefy 14nm Broadwell-E chips too.

Speaking of those Extreme Edition chips, it looks like we'll be getting new LGA 2011-compatible sockets from mobo manufacturers soon. After Asus's bespoke OC Socket on its X99 range surprised the industry, Gigabyte is joining in with its own 2,038-pin socket, taking advantage of some extra voltage control and DDR4 overclocking capabilities.

Stepping outside of the capacious innards of your PC box though, Intel is also preparing an intriguing little Bay Trail-powered device to launch this year—the Compute Stick. Packing a Z3735F chip into a design that's only four inches long, the Compute Stick is a super-tiny PC that you plug directly into an HDMI port to turn almost any display into a PC. The $150 device comes with Windows 8.1, 2GB RAM, and 32GB of solid-state storage. Because the Bay Trail chips are the first Atoms to come with proper Intel HD Graphics, it could be a fine game-streaming device.

AMD PROCESSORS

New APUs are not to be confused with spicey Spanish sausage or redheaded stars of *NYPD Blue*

WHILE AMD ALWAYS seems to be in the midst of some sort of transition, its current shape *is* changing quite dramatically. From the appointment of Lisa Su as CEO last year, and the departure of John Byrne at the start of this year, AMD looks to be repositioning itself as a tech firm led by its engineers rather than its musketeers. Or marketeers. We forget which. One flounces around with over-stylized facial hair, dandified clothing, and a reckless disregard for anything but themselves. The others are musketeers. Ha.

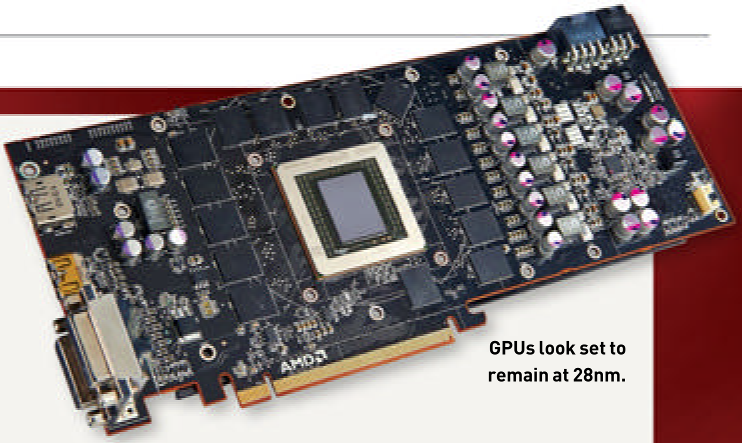
Tech-wise, the processor half of AMD is most definitely evolving, with 2015 being the intermediate year and 2016 set to introduce the real fruits of its current labors. Or that is the ever-mutable plan anyways. The big push for mid-2015 will surround the release of its new Carrizo APUs, the follow-up to the Kaveri range launched at the start of last year. It introduces a new Excavator core and GPU component, plus will be the first full HSA 1.0 chip, the goal being to implement totally transparent hardware where apps can access any part of the tech directly and unfettered, whether that's CPU, GPU, or memory components.

The Excavator core is the last hurrah of the outgoing Bulldozer architecture, and should give the Carrizo APUs a little performance boost, likely up to 10 percent in CPU terms. The GPU component is coming from the Tonga GPU of R9 285 fame. Sadly though, Carrizo is a resolutely mobile part, destined to never arrive on the desktop. Along with the low-power, Puma processor-toting Carrizo-L, AMD is looking to compete with Broadwell-U in the thin 'n' light laptop space.

This year is also set to see the rise of AMD's Project Skybridge, its ambidextrous platform set to provide a pin-compatible setup which will take either an x86 Puma+ based SoC or an ARM Cortex-A57 with an integrated GCN-class GPU. Again though, we're talking about mobile parts—AMD desktop aficionados are going to have to wait until 2016 to get a bead on its high-end K12 Zen processors.

AMD GRAPHICS CARDS

Hawaii, Caribbean, or Pirate? We don't care, just make 'em quick



GPUs look set to remain at 28nm.

IF 2015 IS LOOKING LIGHT on the processor front for us desktop PC folk, it should be a more exciting 12 months for the graphics half of AMD. Its strategy looks like a two-pronged attack on Nvidia. The first will be a refresh of its top-end Hawaii-based graphics cards, while the second will see the launch of its new Caribbean Island range.

The Hawaii refresh is likely to produce a small performance boost over the existing R9 290X, but will essentially be a mildly tweaked Hawaii core taking advantage of the matured manufacturing process allowing for more reliable, higher clock speeds, and potentially less heat. We were expecting this refresh at the tail end of 2014 in order for AMD to introduce some competition for the new Maxwell cards, but we're now expecting them early this year instead. And given the refresh is now happening in 2015, it could be branded as an R9 380X instead.

The Caribbean Islands (née Pirate Islands) cards will be coming a little later, with current guestimates suggesting June. From shipping manifests, and the ever-grinding rumor mill, it looks like final silicon has started moving around the globe. It's likely then we're moving into mass production of AMD's next-gen GPU.

The rumored specs for the purported Fiji XT GPU—the chip possibly powering the R9 390X—has it containing a mammoth 4,096 streaming processors with a 4GB frame buffer. That mightn't sound much, but the video memory should be the first release of a GPU with the high bandwidth memory (HBM) AMD has been working with Hynix to produce. HBM is similar to the 3D stacked memory in Samsung's latest SSDs, using TSV interconnects to boost bandwidth through the stacked video memory. That should give AMD's new GPUs huge bandwidth numbers, perhaps three times that of the GTX 980.

What's less clear is the production process. Given AMD's historically hot and power-hungry GCN GPUs, we were expecting AMD to need the 20nm lithography. But the purported prohibitively poor yields of high-end 20nm parts means we might not see *any* 20nm GPUs from either company. AMD has stated it's producing 28nm and 20nm parts this year, moving on to 16nm in 2016, and with the lighter transistor load of Carrizo being announced at 20nm, it looks like the GPUs will need to remain at 28nm.

NVIDIA GRAPHICS CARDS

There's a Titan waiting in the dark, ready to pounce

THIS YEAR IS LIKELY to be more of a reactive year for Nvidia in the graphics game. It's going to be busy enough though with its new mobile processing beast, the 256 CUDA-core'd Tegra X1. But that's not to say we won't see movement from the green team on desktop GPUs. We've already had the release of the middle order Maxwell GPU, with the GTX 960 rocking a new GM 206 GPU. That gets Nvidia's current generation to a state where it can wait to see what its rivals do before releasing anything else.

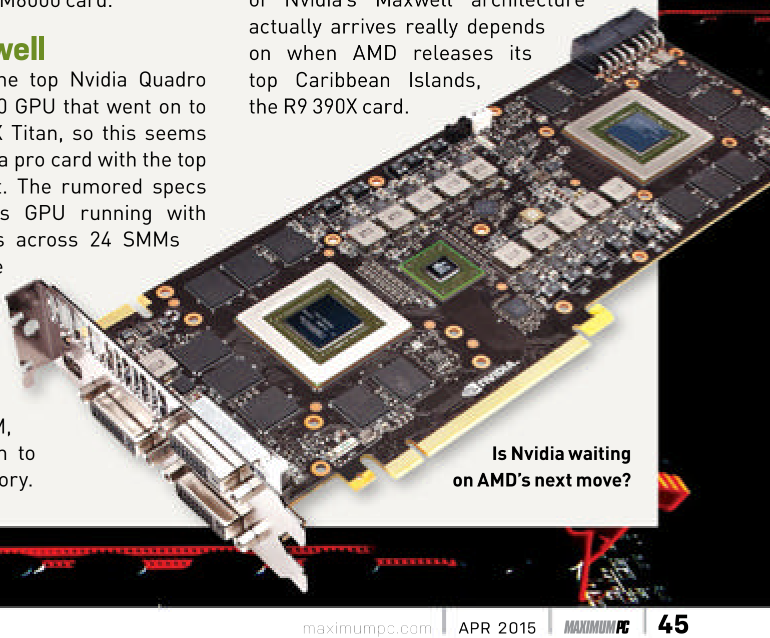
And that's likely to be how the rest of the year goes. Nvidia will be waiting in the wings for AMD to drop its new R9 3xx series of cards, holding fire until it can get a bead on exactly how this new generation of GPUs stands against its own. Once the full might of the R9 390X is known, that's likely when we'll see the full power of the Maxwell graphics architecture.

As with Kepler before it, we know the GM 204 GPU inside the GTX 980 is not the pinnacle of its new technology. There will be a full GM 200 part being prepped for the next professional cards, which will then find its way into a GTX Titan card and maybe a GTX 980 Ti, too. There are already reports of the GM 200 GPU, most recently a GPU-Z validation submission detailing a Quadro M6000 card.

Mighty Maxwell

The K6000 was the top Nvidia Quadro running the GK 110 GPU that went on to feature in the GTX Titan, so this seems to make sense for a pro card with the top Maxwell GPU in it. The rumored specs have the Quadro's GPU running with 3,072 CUDA cores across 24 SMMs with a mighty large 96 ROPs. A previous SiSoft Sandra database entry detailed a 3,072-core card with 12GB of VRAM, which would seem to corroborate this story.

The subsequent Titan release (possibly a Titan X) will likely come with the same GPU configuration but probably a smaller frame buffer, perhaps the same 6GB that the existing Titan houses. But when the new ultra-enthusiast SKU of Nvidia's Maxwell architecture actually arrives really depends on when AMD releases its top Caribbean Islands, the R9 390X card.



Is Nvidia waiting on AMD's next move?

SOLID-STATE DRIVES

Get ready for a big SSD fight over NVMe

It's all change in solid-state land this year.

OK, THIS YEAR looks like becoming a serious scrap in the SSD world. Things have been shaken up entirely by the demands of the new NVMe standard to replace the existing AHCI protocols that rule both current SATA and M.2-based SSDs. That means 2015 will see a raft of new SSD controllers and all the usual suspects are involved—it's going to be fascinating watching how it all shakes out.

Samsung has already gotten its NVMe SSD controllers running in the enterprise world, so expect to see that roll out to its consumer drives later on this year. The SM951 is the M.2 NVMe set to replace the XP941 we've already tested and has just gone into mass production. It's also PCIe 3.0 compatible, running over four lanes to offer sequential read and write speeds of a reported 2,150MB/s and 1,550MB/s respectively. That drops over PCIe 2.0, but still looks seriously quick.

Comeback kid OCZ is also prepping a shiny new NVMe controller, called the JetExpress. Again it's PCIe 3.0 compatible across four lanes with potentially 10 NAND channels per controller chip. In the enterprise world, where the JetExpress will first hit, it's possible to double down on the controller chips to boost performance. Whether that will come down to the future consumer versions we don't yet know.

But OCZ-owner Toshiba hasn't been demonstrating the fruits of collaboration, instead using a new Marvell NVMe controller to make up the single package SSD it's been showing off at the start of the year. The unit Toshiba has been demonstrating packs 128GB of Toshiba NAND into a package with the controller to make a single-chip SSD that's smaller than an SD card.

That's likely to be the new 88NV1140 controller from Marvell, designed for small form factor mobile devices, but it's also started demonstrating its 88SS1093 controller designed for PCIe 3.0 M.2 drives running on NVMe protocols. Again, it will be a four-lane setup, backwards compatible with PCIe 2.0. This is probably going to be the most prevalent controller in a range of SSDs, with Crucial/Micron again likely to base its NVMe drives on Marvell.

But SandForce isn't dead and buried. It's coming back with the SF3700 which has been shown off in the upcoming ADATA SR1020 M.2 drive. It's another NVMe-capable controller, but the top-end SF3759 option only stretches up to four-lane PCIe 2.0 connections. Still, with those caveats the ADATA drive was hitting 1,800MB/s on both reads and writes. SandForce says it's also gotten around the incompressible data problems, shutting off its own compression algorithms when it comes to the tricky data sets.

COOLING

An explosive year for PC cooling?

Chip chillers could be going plastic fantastic.

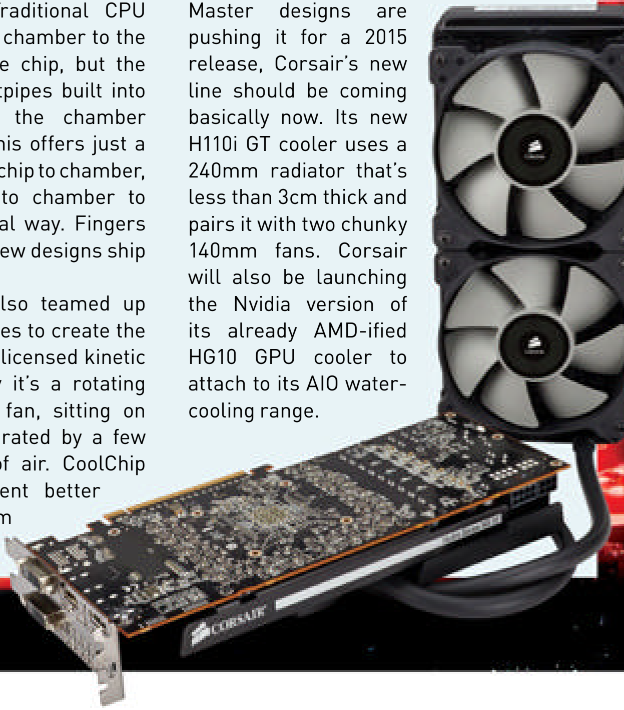
SOME INTRIGUING DEVELOPMENTS are set to happen in PC cooling this year and one of the most interesting uses plastic explosive. Don't worry, CapTherm isn't asking you to strap some C-4 to your CPU. It's using a process called explosion bonding to join dissimilar metals to form a mixed copper, aluminum, and stainless steel radiator for its vapor-chamber cooler. It also uses a refrigerator coolant inside with a far lower boiling point than water to help dissipate heat from the CPU quicker and more efficiently than a standard air or water cooler.

Using the phase change from liquid to vapor, the MP-1240 cooler can absorb a huge amount of energy, up to 325W. This is a relatively new way of putting together CPU coolers, and because CapTherm is only a small Canadian startup, the initial products are likely to be hugely expensive. It is though, more likely to be looking to license its technology than really become a full manufacturer in its own right.

Cooler Master is also up to new things and has been busily showing off new CPU block designs which fully incorporate 3D vapor chambers. Traditional CPU blocks restrict the vapor chamber to the plate in contact with the chip, but the new design has the heatpipes built into block itself, extending the chamber vertically inside them. This offers just a single heat transfer from chip to chamber, rather than from chip to chamber to heatpipe as is the normal way. Fingers crossed we'll see these new designs ship later this year.

Cooler Master has also teamed up with CoolChip Technologies to create the consumer versions of its licensed kinetic cooling tech. Essentially it's a rotating heatsink, in place of a fan, sitting on the CPU baseplate separated by a few microns-thick cushion of air. CoolChip says it offers 50 percent better cooling in a smaller form factor, with less noise too. The holy grail of cooling tech then. It could be at a great solution for notebooks.

But if those Cooler Master designs are pushing it for a 2015 release, Corsair's new line should be coming basically now. Its new H110i GT cooler uses a 240mm radiator that's less than 3cm thick and pairs it with two chunky 140mm fans. Corsair will also be launching the Nvidia version of its already AMD-ified HG10 GPU cooler to attach to its AIO water-cooling range.



MOBILE TECHNOLOGY

Desktop GPU power for tablets and full desktop CPUs and GPUs for your laptop. Boom!

FROM A MOBILE STANDPOINT, Nvidia's latest SoC is probably the most exciting. The Tegra X1 is the Maxwell-powered successor to its Kepler-based Tegra K1 chip, and brings a pair of the same SMM modules you'll find in the GTX 980 into a 20nm SoC. That provides 256 CUDA cores and 16 ROPs in a mobile chip, which will deliver some serious graphics power. The chip has a 1GHz top clock speed, which will allow it to deliver a full 1 TFLOP of graphical processing, though in tablet form factors it's unlikely to be able to sustain this speed for very long.

But because Nvidia had always been looking toward the mobile sector when designing Maxwell, the new TX1 is capable of bringing all that extra performance to bear with lower power demands. The next SHIELD Tablet could be an absolute beast.

AMD is focused on its own laptop chips in the form of Carrizo. As we've said earlier, it's the successor to Kaveri and brings the new Excavator cores and Tonga GPU to the mobile APU market. Whether it gets many design wins though is debatable, which is a shame given that it's likely to be very powerful, with potentially almost double the GPGPU performance of Iris Pro.

Put a dock in it

We'll also see Broadwell and Skylake mobile chips this year, though likely only full quad-cores on the Broadwell side this summer. Still, they'll be drop-in upgrades and we're seeing an interesting new trend emerging in laptops: the gaming dock.

MSI will ship the GS30 with its Gaming Dock this year, offering a slimline i7/Iris Pro laptop with a x16 PCIe connection to a base dock. With extra storage, audio, and support for full desktop PSUs and GPUs, the dock will essentially turn your laptop into a desktop when you're at home.

But you can have desktop goodness in laptop form too. MSI's GT80 Titan has got a full mechanical switch keyboard while Clevo has created a design housing full desktop processors in a 4kg notebook. A few system builders have already signed up to use the designs, as they're looking to produce more custom builds than the future BGA-only CPU designs will offer.

Say hello to your new desktop.

CONNECTIVITY

It's going to be a cabling revolution, people

CABLES, HUH? Connections. Mmmm, fascinating… But seriously, fascinating! This year is going to see a bit of a cable renaissance as the increased amount of power and data we're looking to shift between systems and devices is moving upwards at a pace the current connections simply can't keep up with.

First off we've got the update to USB coming in 2015, moving us to USB 3.1 and doubling theoretical transfer rates up to 10Gb/s, putting it on a par with the first iteration of Thunderbolt. At CES in January, MSI was demonstrating an X99 motherboard, shipping in Q1 2015, with a pair of USB 3.1 ports. It had a pair of Intel SSDs in RAID 0 to raise the bandwidth roof, hitting a full 695MB/s writes.

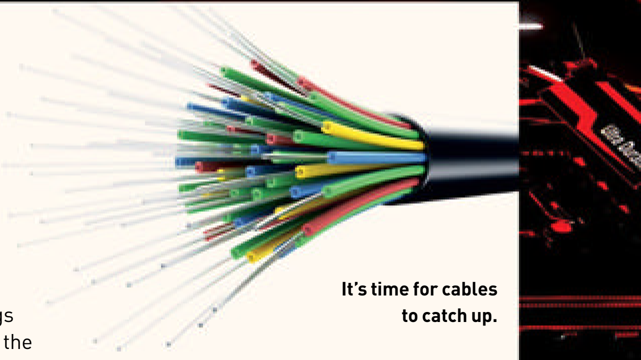
We also saw some demonstrations of Samsung's SSDs in RAID topping 800MB/s. The fact that folk are having to RAID SSDs to show what the connection is capable of is quite astounding.

The next update to USB is even more exciting though, giving us the new Type-C connector. We've had to put up with mono-directional plugs for many, many years now, but the reversible Type-C connector will put pay to the most annoying part of USB connectivity—*always* getting it the wrong way up. Not only that but Type-C is also able to offer boosted power delivery too, from 5W to 10W up to 100W. Being able to charge your laptop and phone from the same cable will soon be a possibility.

Port of cool

Type-C though can do even more, potentially doing away with the need for any display ports too. The "Alternate Modes" feature allows for video as well as data and power to pass along the cable. VESA has created an alternate mode, linking with DisplayPort 1.3, allowing a single cable to provide 10Gb/s bidirectional data, a 4K video stream, and 100W of power. Are we going to start seeing Type-C ports on graphics cards? Quite possibly by the end of the year and they're coming to mobos very soon.

But what if you want more than 4K? In order to hit 8K, the Mobile High-definition Link (MHL) Consortium has come up with the superMHL cable and connector. The full six-lane version will be capable of 8K at 120Hz and up to 40W of power, but needs its own cable. Like Type-C it's going to be reversible (yay!) and we're likely to see versions with both superMHL at one end and USB Type-C at the other.



It's time for cables to catch up.

MONITORS

Will it be the year to sync some money into a gaming screen?

Want potential refresh rates of up to 144Hz?

COULD THIS BE THE YEAR the perfect gaming monitor arrives? Given the amount of progress over the last 12 months, we're hoping 2015 will bring us mighty close to the holliest of grails.

The big news will be around refresh rates. Oh yeah, sexy time. The most exciting part is we're not far from getting 120Hz/144Hz IPS gaming monitors on our desktops. Asus's upcoming MG279Q isn't an ROG panel, but it's got serious gaming chops with its 27-inch IPS panel sporting both a 1440p resolution and a refresh rate up to 120Hz. Speaking with Asus, it reckons the MG279Q might even get up to 144Hz if its engineers can get the electrics and panel to play nice together.

But what of GPU synchronization? Well, this panel isn't a G-Sync panel, but it will support DisplayPort 1.2a, so it will support Adaptive-Sync and the compatible Radeon card will then be able to deliver FreeSync smoothness. Fun. And for AMD folk, 2015 will be the year of FreeSync. Asus's new gaming panel may not be FreeSync branded, but BenQ, Viewsonic, LG, and Samsung have all announced screens that are. It's a wide spread of screens, from 27-inch, 1080p, 144Hz panels, to 31.5-inch, 4K screens at 60Hz.

Panel beaters

But what of G-Sync? Well, Acer is set to make a splash with its 27-inch, 144Hz, G-Sync screen, mostly for the fact it's rocking an IPS panel. There's a possibility it's actually an AU Optronics AHVA panel, but they're almost indistinguishable from IPS screens anyways. Asus is also fleshing out its G-Sync line with a 4K IPS screen rocking Nvidia's syncing hardware, the ROG Swift PG27AQ.

And if you're already bored of 4K resolutions, LG is introducing its Z27q, a 27-inch panel with a 5120x1880 resolution. So, if you thought Windows scaling at 4K was bad...

PERIPHERALS

Membrane or mech switch? This year you may need to choose

Get ready for Mad Catz's "future-proof" RAT ProX.

KEYBOARDS are probably going to show the biggest change in this coming year, with the inexorable rise of the mechanical switch looking to take over entirely. Not just content with jumping into the gaming laptop market with the crazy MSI GT80 Titan, the not-so-humble mechanical switch keyboard is trying to ape membrane switch boards on your desktop too.

SteelSeries is producing a board called the Apex M800 with a set of QS1 switches. These new switches aim to offer the performance of a linear mechanical switch with the feel of a membrane switch. So even if the clicky feel and tall key caps of mech switches puts you off, you'll still be able to get the accuracy and reliability with the same membrane smoothness. The M800 should be released in just a few months, though is likely to have a pretty hefty price tag attached.

But Cherry, the main mech-switch maker, is also working on a new switch. It's called the Cherry RK, or RealKey, and it uses an analog controller designed to offer a 1ms response time within the keyboard itself. Current switches rely on a digital controller to tell when a key has been pressed a single time, which Cherry has measured at a 20ms response. Another upshot of this is that ghosting isn't possible as every key produces its own analog signal, so according to Cherry, ghosting "simply does not happen." It's only going to be available on the Cherry MX Board 6.0 as it isn't licensing the tech out just yet, so expect to see it around Q1 this year.

We'll also probably see advances in optical sensors, as they start to catch up with laser opticals in terms of speed, so gaming mice fans shouldn't feel too left out. And with Mad Catz promising the release of its RAT ProX they really shouldn't. Billed as the most future-proof mouse ever, the ProX is designed to allow different modules to be upgraded by the end user. We're used to the RATs being customizable, but being able to change the sensor itself is unprecedented. At launch there will be three different sensors available: Philips 2037, Avago 9800, and the Pixart 332WM10. You can choose whichever one you want at purchase, or buy upgrades at the Mad Catz store.

VIRTUAL REALITY

Strap on your goggles and lose the rest of the world

The VR vanguard is no longer just Oculus.

ONE OF THE BIGGEST CHANGES in tech is that virtual reality has become an actual category of product rather than just a singular entity. Of course the Oculus Rift is still going strong in the vanguard of the latest VR revolution, but a number of other manufacturers have now thrown their helmets into the ring.

Several industry players have formed the Open Source Virtual Reality (OSVR) ecosystem, including Sixense, Razer, and Leap Motion. Razer is going to be offering its OSVR Hacker Dev Kit in June. At $200, it has everything you need to get started, with a headtracker, display, and optics all included. But with the onus being on open source-ness, you can already download the prototype's schematics and components list if you wanted to build your own device from scratch.

This isn't going to be about putting together some next-gen Oculus beater though, more about getting affordable VR into developers' hands so they can get on with giving us more involving worlds for us to get virtually obsessed with.

Joining the revolution

There are also rumors floating around that the long-awaited consumer version of the Oculus Rift (CV1) is being slated for release this winter. Details are still sketchy and nothing has been confirmed. Indeed an interview with UK newspaper *The Telegraph* was altered to remove a section that purported to have CEO Palmer Luckey estimating a winter 2015 release of CV1. Oculus is also remaining tight-lipped about the resolution, meaning we may end up with the device displaying at 1080p, but using downsampling (such as Nvidia's Dynamic Super Resolution) to create a sharper image.

Inputs are going to be hugely integral to the success of this second coming of VR and Sixense is looking to be at the fore. Its STEM system is the evolution of its collaboration with Razer in designing the Hydra controller. It's wireless and uses magnetic fields to track movement. The setup looks incredible and is the sort of thing that will make or break VR. The initial three-tracker setup is more than the cost of a DK2 Oculus Rift though and is set to ship in May or June.

OPERATING SYSTEMS

Microsoft takes a hop, skip, and a jump to a new OS. Hell, it's a whole new ecosystem...

You'll be able to play Xbox One games on any Windows 10 device.

LATER THIS YEAR we should see the final launch of Microsoft's next operating system. And to sweeten the deal, Microsoft is set to distribute Windows 10 gratis for the first 12 months for both Windows 8.1 users and Windows 7 folk. That last bit is important as it shows Microsoft is determined to pull the Win8 naysayers from their Win7 bolt holes.

Microsoft is also looking to create a unity between Windows 10 on the PC, phone, and tablet. And also on the Xbox. Yes, you read that right. Xbox. With a new pre-loaded Xbox app for Windows, you'll be able to connect to an Xbox One and play your console games on any Windows 10 device. Of course, with our powerful gaming PCs, we'd be more interested in doing it the other way around, taking our games into the living room with the Xbox console, so hopefully that will also be made an option.

Still, because MS is talking about streaming to *any* Windows 10 device, that means low-power laptops, tablets, and phones too. That's the sort of unified setup that Microsoft has been chasing for years. Taking that even further, with the release of DirectX 12, Xbox and PC gamers will be able to play together. The next *Fable*, *Fable Legends*, has been revealed as allowing Xbox and PC gamers to enjoy the game together. Whether that will be limited to co-op games or open to competitive multiplayer, *CoD*-style gaming too, is still unclear. The age-old problem of mouse-accuracy versus joypad sensitivity is always going to be a thorny subject.

And, as we've mentioned in the past, there is a Start menu for the new operating system—though with the new "Continuum" design (the method for the OS to mold itself to whatever device it's running on) you can explode it to take over the whole screen for that Win8 nostalgia. MS is also bringing its phone-y personal assistant, Cortana, to the desktop. With Windows 10 then you can have a personal relationship with your PC that people aren't going to think is really creepy. And our offices will be filled with people not just shouting at their computers, but having them shouting back too.

It certainly looks like Microsoft has learned from the difficulties it had moving people to Win8, and Win10 could be the most inclusive, versatile, and powerful OS we've ever seen on the PC. Poor Linux...

GAMES PREVIEW 2015

The upcoming games worth getting excited about

by Daniel Griliopoulos

With every year, the PC lineup only gets more crazy. While console firms pay millions for temporary exclusives, the PC has so many exclusive games each year it's untrue. And many of them are now free, from twine and inform text adventures, to endless Ludum Dare titles such as *Titan Souls*, to huge AAA games like *Path of Exile*. No console lets developers just experiment like the PC does.

Every developer with any sense will co-develop for PC, as all the console creators have dumped their fancy tech and the machines are now standardized, repackaged PCs, meaning every game that isn't a platform exclusive tends to end up on PC. What was there that was worth buying a console for in 2014? *Destiny*, a handful of derivative Mario- and Zelda-related exclusives, and... Actually, that might be it.

So compiling a list of the games to look out for in 2015 is a huge task. We've picked out just a few here, with one major thing in mind—no list is definitive and every list is personal. These are the games we're most excited about, meaning some big, eagerly anticipated titles, such as *Evolve* and *Dying Light*, didn't quite make the cut. So, without further ado, here's our list. Some might surprise you!

Pillars of Eternity

Release date: 26 March

The Infinity Engine games—*Baldur's Gate, Planescape: Torment, Icewind Dale*—are the stuff of RPG legend. *Pillars of Eternity* is a loving recreation of that party-based RPG genre, replete with witty dialogue, puzzle-heavy combat and hand-drawn 2D fantasy locations. It's also one of the biggest Kickstarter successes of all time, netting nearly $5 million.

» **Developer** Obsidian
» **Publisher** Obsidian, Paradox

MINECRAFT STORY MODE

Release date: TBA

From the people who made *The Walking Dead*, *Game of Thrones*, and *The Wolf Among Us*, comes... *Minecraft*?! It's as an adventure game though, available in episodic form and featuring characters from the original game. No, we're not making this up. Mojang has said: "We're not creating an 'official' story for Steve, or explaining the world of *Minecraft* in detail. It will be a cool game." That's all we know!

» **Developer** Telltale » **Publisher** Microsoft

Total War: Attila

Release date: Out now

Wonderfully rejigging *Total War: Rome II*, *Attila* quickly skips over the broken bits of that game, and changes how factions behave. Expect campaign and battle improvements, such as better maps and the return of the family tree system. It also introduces nomadic cultures, who live in tents and move in giant hordes, including the Huns. Starting in 395 AD, this is really the story of the fall of the Roman Empire, at the hands of Attila.

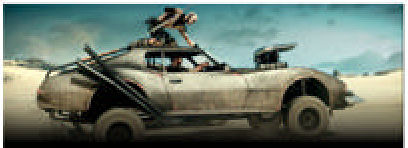
» **Developer** Creative Assembly
» **Publisher** Sega

Grim Fandango: Remastered

Release date: Out now

LucasArts' final masterpiece is set on the Day of the Dead. You play Manny, a travel agent tasked with shipping the dead to the next level of Hell.

» **Developer** Double Fine
» **Publisher** LucasArts

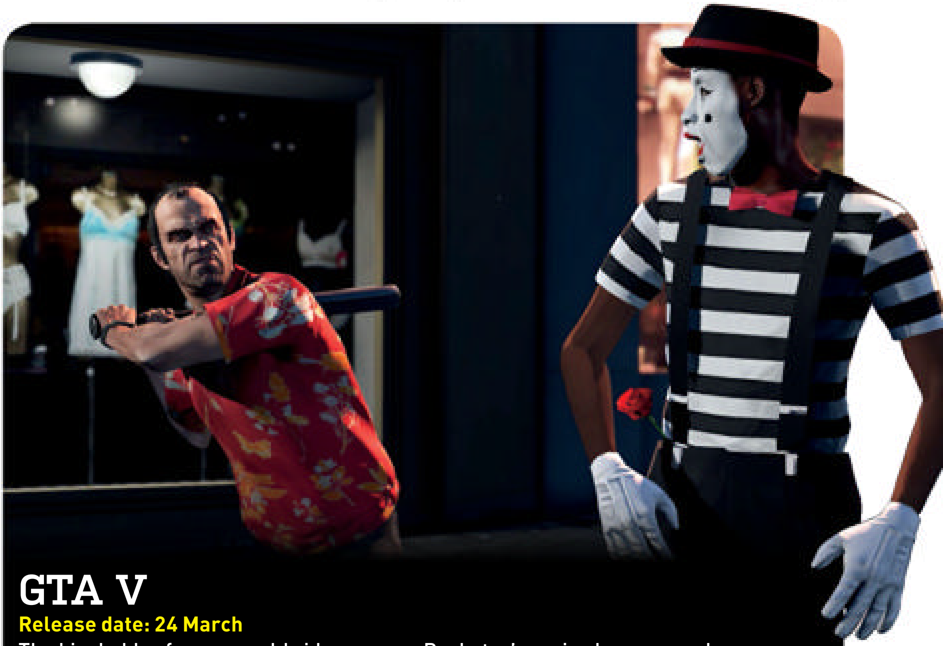


Mad Max

Release date: TBA

From the makers of *Just Cause* comes this open-world car-action game based on the famous movie franchise.

» **Developer** Avalanche
» **Publisher** Warner Bros

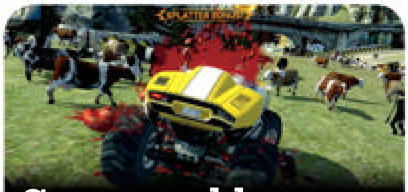


GTA V

Release date: 24 March

The big daddy of open-world video games, Rockstar's series has come a long way since DMA Design's top-down arcade game. Number five has been out for a long while on console, but frankly it was as ugly as a politician's soul until the PS4/Xbox One release. It's a grisly, misanthropic farce, following three unlikable characters as they cause shooting and driving chaos in a huge open world (AKA LA). Its multiplayer mode, GTA Online, is almost a game in itself.

» **Developer** Rockstar
» **Publisher** Rockstar

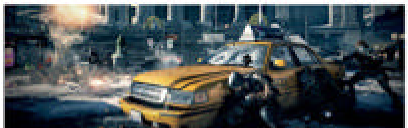


Carmageddon: Reincarnation

Release date: 27 March

The 1990s' most bloody (and controversial) car game is back. Racing comes second here to running down pedestrians.

» **Developer** Stainless Steel Games
» **Publisher** Stainless Steel Games



The Division

Release date: TBA

An open-world third-person shooter multiplayer role-playing survival game set in the Tom Clancy universe. It's still in early development.

» **Developer** Ubisoft Massive
» **Publisher** Ubisoft

Mortal Kombat X

Release date: 14 April

The long-running fighting game series was rebooted in 2011, killing off many of the franchise's characters. This latest iteration carries on from that game, before slowly moving 25 years into the future, having the series' aging veterans face off against the offspring of their compatriots. In terms of mechanics, each character now has three variations, with different styles of play and special moves.

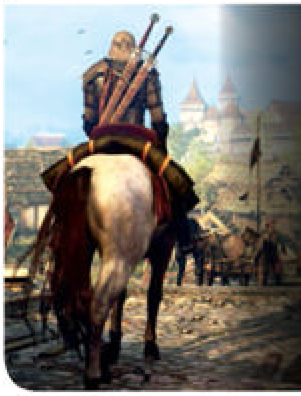
» **Developer** NetherRealm Studios
» **Publisher** Warner Bros

Galactic Civilizations III

Release date: 14 August (Early Access now)

Though *Civilization* established the 4X genre, many would argue *GalCiv* perfected it. This long-awaited third game lets you create and rule a highly customized spacefaring civilization. You can explore everything from mass cloning to starkiller weaponry. Oh, and it'll only run on 64-bit PCs!

» **Developer** Stardock
» **Publisher** Stardock

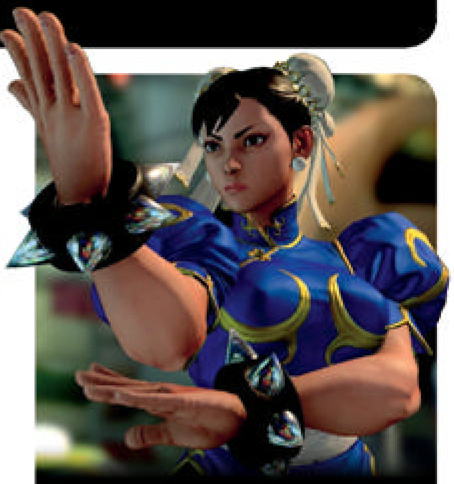


The Witcher 3: Wild Hunt

Release date: 19 May

Considering its origins in obscure Polish fantasy novels, it's stunning that *The Witcher* is still such a big deal, but the series has proven consistently original, tough, and divergent. *Wild Hunt* moves to an open world 30 times larger than the previous two games and bigger than *Skyrim*. It's also introducing underwater swimming, horseback combat, a day-night cycle, and a huge array of monsters, plus it's concluding the twisty story.

» **Developer** CD Projekt Red
» **Publisher** Bandai Namco

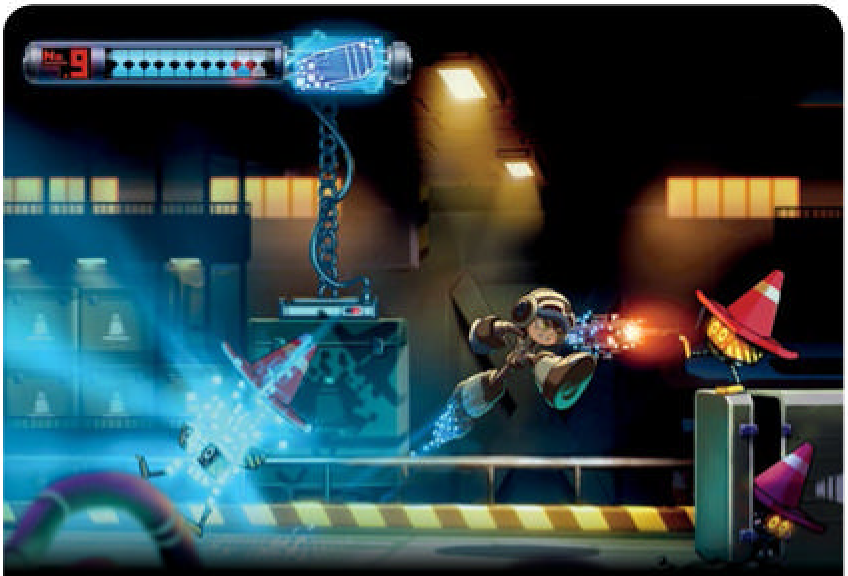


Street Fighter V

Release date: TBA

If it's not the best fighting game of all time, it's certainly the most popular. For many years, PC versions of *Street Fighter II* were made of twigs and paper, liable to fall over at the slightest dragon punch. But the recent iterations of *Street Fighter IV* on PC have been hugely polished. This new release is, controversially, going to have cross-platform play between PC and PS4.

» **Developer** Capcom
» **Publisher** Capcom



Mighty No. 9

Release date: April

The spiritual successor to *Mega Man*, Keiji Inafune's most famous creation, the *Mighty No. 9* is a classic side-scrolling action game. You play as Beck, the ninth in a series of powerful robots, and the only one not infected by a mysterious virus that's sent robots across the world haywire. You can transform your body, changing legs and arms to get past obstacles and enemies, and learn new abilities from the robots you defeat. Graphically it moves like a kid's cartoon, much like the bizarre *Cuphead*.

» **Developer** Comcept, Inti Creates

» **Publisher** Comcept

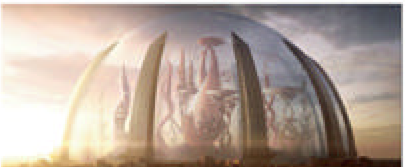
That Dragon, Cancer

Release date: Mid-2015

A game about what it's like to raise a son born to die. It's sure to be divisive.

» **Developer** Ryan and Amy Green

» **Publisher** Ryan and Amy Green



Torment: Tides of Numenera

Release date: Late 2015

The spiritual sequel to *Planescape: Torment* is a story-driven RPG, focusing more on character than combat and loot collection.

» **Developer** InXile » **Publisher** InXile

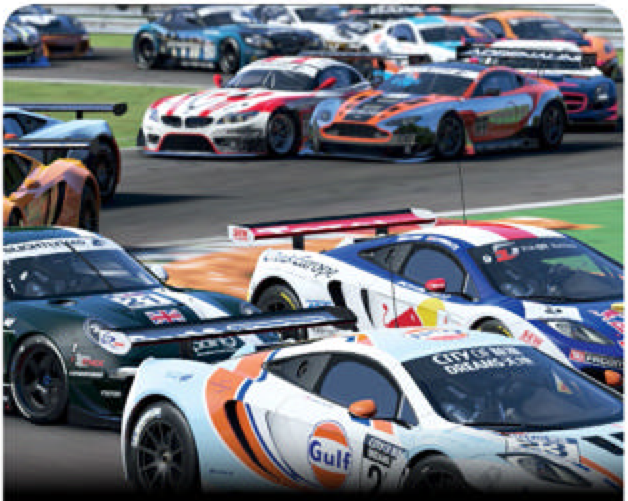
Chaos Reborn

Release date: May (Early Access now)

Julian Gollop is best known for his *XCOM* series, which was recently rebooted by Firaxis. But *Chaos* is the game he always wanted to remake and Kickstarter has now let him—*Chaos Reborn* is a nicely polished modern version of the rather unusual wizard combat simulator. Players take turns to cast spells and summon monsters, but it's actually much more complicated than that makes it sound. This new version has a persistent online mode and crafting, but the core game is as tight, complex, and intriguing as ever.

» **Developer** Julian Gollop

» **Publisher** Snapshot Games



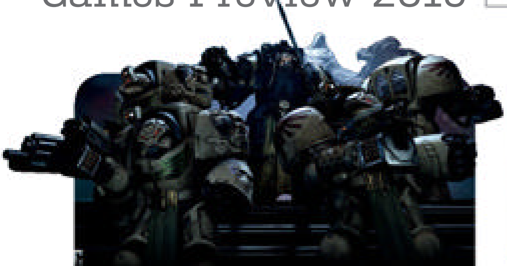
Project CARS

Release date: 17 March

It might have a slightly daft name, but you certainly know what it's about. This heavily delayed crowdfunded motorsport simulator is built on the same Madness Engine as *Need for Speed: Shift* and promises an open sandbox experience, with dynamic day-night and weather cycles. All vehicles and tracks are unlocked from the game's start, and players can attempt multi-day races, compete online, or build a career.

» **Developer** Slightly Mad Studios

» **Publisher** Bandai Namco

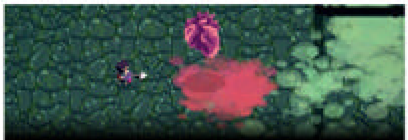


Space Hulk: Deathwing

Release date: TBA

A conversion of the classic board game into a FPS, *Deathwing* is already looking beautifully polished.

» **Developer** Streum On Studio
» **Publisher** Focus Home Interactive



Titan Souls

Release date: Q1

Imagine a *Zelda* game that's all boss fights? That's *Titan Souls*. The extra twist is that you have a single arrow to do it with.

» **Developer** Acid Nerve
» **Publisher** Devolver Digital

The Witness

Release date: TBA

Designer Jonathan Blow has only made one commercial game so far—but the care he put into *Braid* demonstrated why his follow-up, *The Witness*, is so anticipated—and why it's taken so long. It's a first-person puzzle game like *Myst* or *The Talos Principle*, where players wander an uninhabited island covered in ruins, deciphering the story as they discover hidden audio logs from previous visitors. Many of the brain-teasers are mazes and, as you complete them, you'll unlock access to a central set of puzzles inside the island's mountain.

» **Developer** Thekla
» **Publisher** Thekla

Hellraid

Release date: TBA

While we wait (and wait and wait) for Bethesda to give up on *The Elder Scrolls Online* and make a new *Skyrim*, *Hellraid* seems tailor-made to fill the gap. By the team behind *Dead Island*, this is a first-person hack-'n'-slash game built around four-player co-op. You play a cursed man in a world based on old European folklore, and fight a series of monstrous enemies with magic, swords, and bows as you raid Hell itself.

» **Developer** Techland
» **Publisher** Techland

Mushroom 11

Release date: Mid-2015

One of the weirdest indie games around, *Mushroom 11* answers the everyday question: "What would happen if sentient fungi took over the world?" You control a mycelium traversing a post-apocalyptic world. As you delete aspects of the fungal mass, it grows everywhere else, meaning that you can move it at high speed by careful editing. It's essentially a post-apocalyptic pruning game.

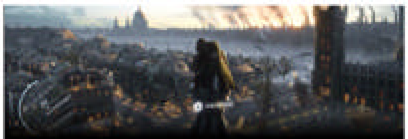
» **Developer** Untame
» **Publisher** Untame

SUPERHOT

Release date: June

A jam game turned full product. A FPS where bullets and enemies only move when you do, making this like a time-based first-person puzzle shooter.

» **Developer** Blue Brick
» **Publisher** Blue Brick



Assassin's Creed Victory

Release date: Fall

The latest in Ubisoft's series will be set in Victorian London. Here's hoping it's better than *Unity*.

» **Developer** Ubisoft
» **Publisher** Ubisoft

Star Citizen

Release date: 2016 (Early Access now)

Chris Roberts, beloved creator of *Wing Commander* and *Privateer*, took the crowd-funding universe by storm when he announced *Star Citizen* back in October 2012. The game quickly hit its funding goals and indeed the clamoring to hand over cash hasn't abated—at the time of writing the game had accrued $69 million of funding, purely from gamers. As far as the game is concerned, *Star Citizen* has lofty aims—it isn't just a space trading sim, it's a "living, breathing science fiction universe with unparalleled immersion." Apart from being able to fly around, it'll be possible to land on planets and space stations and run around in a first-person mode.

» **Developer** Cloud Imperium Games » **Publisher** Cloud Imperium Games

Metal Gear Solid V: The Phantom Pain

Release date: TBA

Though Hideo Kojima's filmic *MGS* series has thrived on the Playstation, its sad history with the PC was restricted to a so-so port of *MGS 2* in 2003. However, last year's *Ground Zeroes* established a toe-hold which will be capitalized on by 2015's *The Phantom Pain*. This time it's set in an open-world Afghanistan with real day-night cycles.

» **Developer** Kojima Productions
» **Publisher** Konami

Just Cause 3

Release date: TBA

Avalanche's series of open-world action games has got impressively huge. The latest installment has Rico Rodriguez returning to take on another petty dictator, with a new ability to scale buildings more easily. It's likely to be set more in skyscraping cities than the low favelas of the past.

» **Developer** Avalanche Studios
» **Publisher** Square Enix

No Man's Sky

Release date: TBA

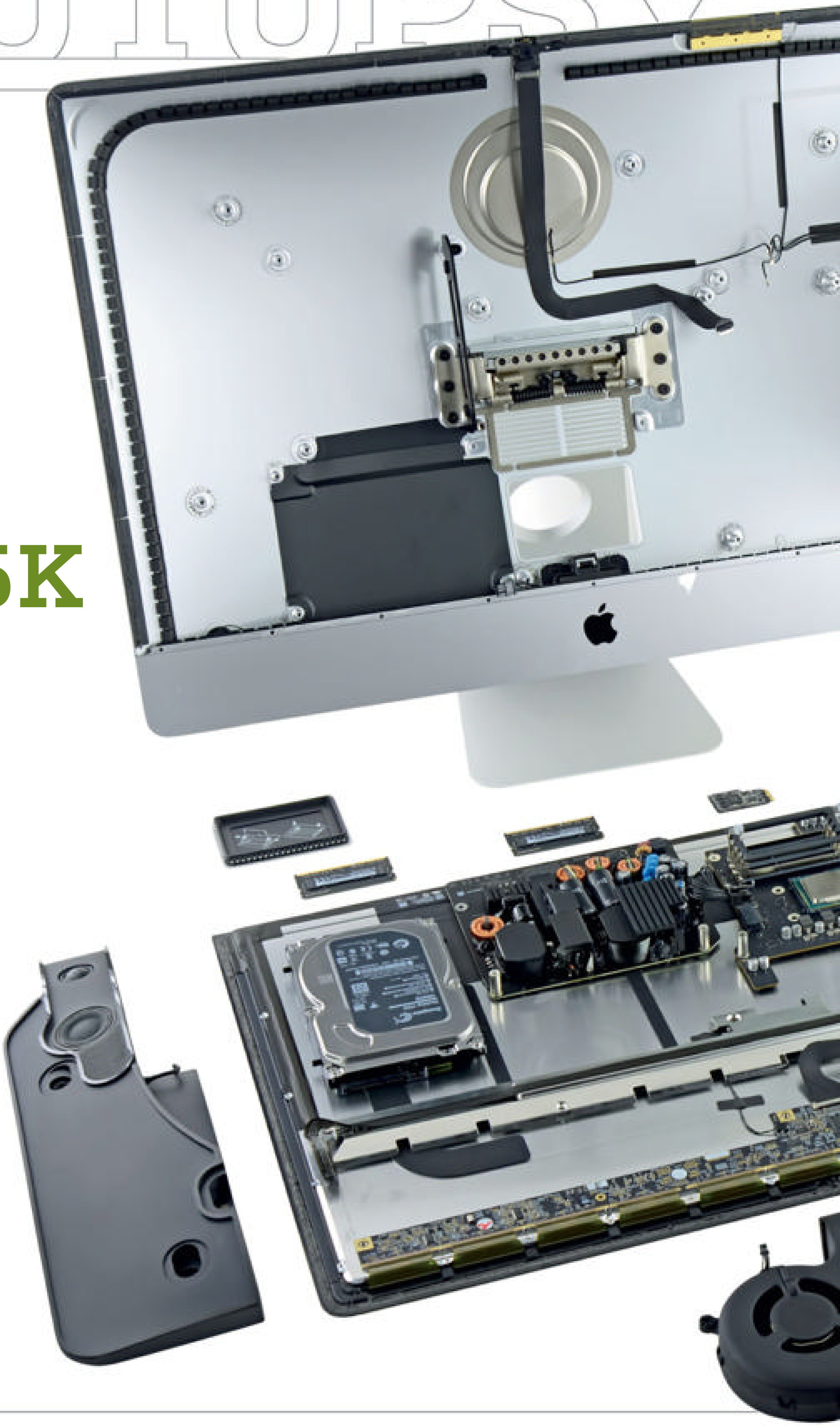
The 2015 game that most developers we know are looking forward to. Hello Games may have only worked on stunt arcade game *Joe Danger* before, but *No Man's Sky* looks hugely ambitious. It's a space opera sim where you explore a procedurally generated but shared universe, both in space and on the surface of bizarre planets. Every scene in the game looks like it's from a 1960s sci-fi magazine cover.

» **Developer** Hello Games
» **Publisher** Hello Games

IFIXIT presents:

AUTOPSY

iMac with Retina 5K Display



About iFixit

iFixit is a global community of tinkerers dedicated to helping people fix things through free online repair manuals and teardowns. iFixit believes that everyone has the right to maintain and repair their own products. To learn more, visit www.ifixit.com.

New display aside, the components inside the new iMac are pretty much identical to the previous model.

BACKGROUND:

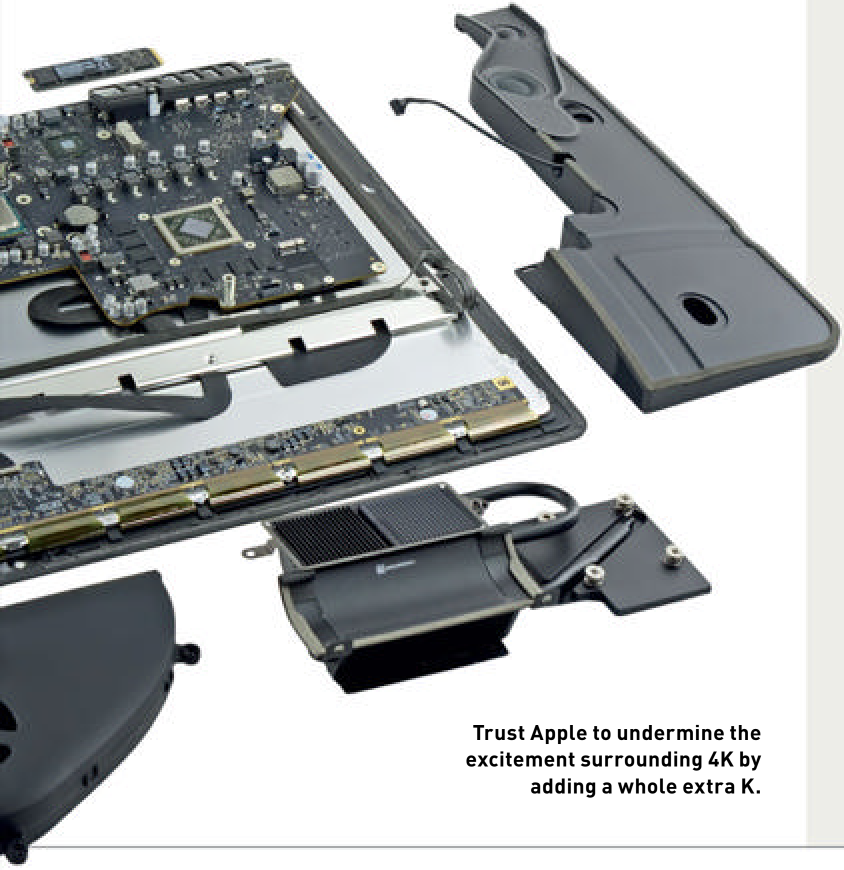
The iMac may be the antithesis of what a computer is about for the vast majority of *Maximum PC* readers (and indeed staff), but there's something cathartic about stripping down Apple's latest offering to the simple components. Essentially this iMac is identical to the previous 27-inch offering, but with that Retina 5K squeezed in to offer up to four times as many pixels. Once you've torn it apart, what you're left with isn't quite so magical. In fact, it's all very straightforward.

MAJOR TECH SPECS:

- 27-inch 5120x2880 IPS display
- Intel Core i5-4690 3.5GHz CPU (3.9GHz turbo)
- AMD Radeon R9 M290X with 2GB GDDR5
- 8GB (2x 4GB) DDR3 1,600MHz SO-DIMMs
- Headphone, SDXC, 4x USB 3.0, 2x Thunderbolt 2, RJ-45

KEY FINDINGS:

- Apple has again relented to demand and placed a memory slot panel on the rear, just above the power connector. You can easily add another pair of 4GB SO-DIMMs to take the overall capacity to 16GB without needing to call on a Genius.
- Popping open the iMac requires a special tool you squeeze into the gap behind the front bezel to ease the screen off. It isn't too difficult, but you'll need to replace the double-sided sticky tape when you piece the machine back together later.
- Disconnect the display ribbons and you'll be left holding the main selling point, the LG display. Lift the bottom bezel off to find the display logic, a long, thin board that extends the full width of the display. It's held in place with a couple of screws, which can easily be removed. Key components on the board are: Texas Instruments NH245 8-bit bus converter; Texas Instruments BUF16821 for gamma correction; timing controller from Parade Technologies DP665 (modified by Apple); power regulator from Texas Instruments TPS65270; and a Texas Instruments TPS65168 for TV LCD-displays.
- The rest of the chassis is almost identical to the previous generation, except the display ribbon has been widened to support the 5K display. The Intel processor can be found on the right-hand side of the mobo. If you want to upgrade the processor, you can, as it isn't soldered to the motherboard.
- Storage depends on what option you've gone for—the iMac is available with just a hard drive, a combo of hard drive and SSD, or just an SSD. Here we've a 128GB SSD using a Marvell 88SS91383 controller connected through a PCIe interface.
- Repairability Score: 5 out of 10 (10 is easiest to repair). The rear panel cover allows you to easily replace the RAM. You can replace the hard drive and processor, though that will mean cutting the tape to get inside. On the whole the components are modular, but the glass and display are integrated. Reassemby demands new double-sided tape.



Trust Apple to undermine the excitement surrounding 4K by adding a whole extra K.

Future

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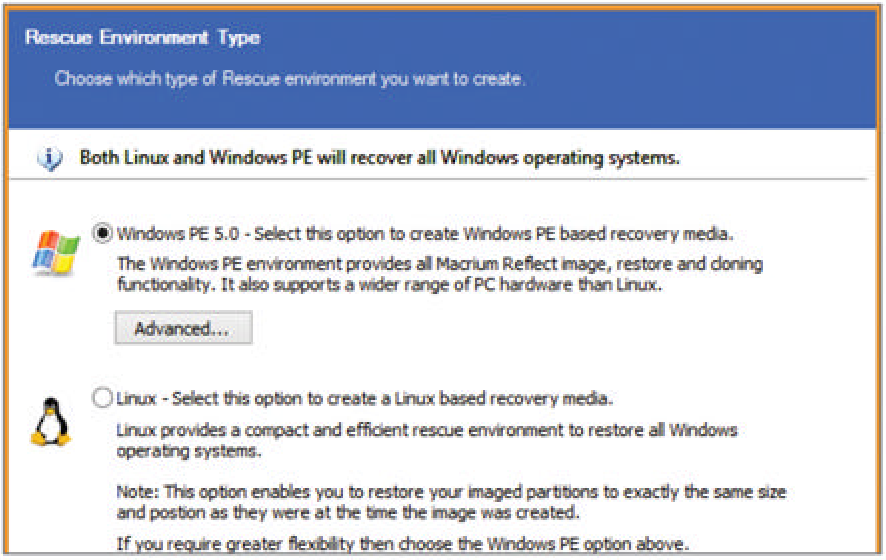
HOW TO

STEP-BY-STEP GUIDES TO IMPROVING YOUR PC

WINDOWS TIP OF THE MONTH



Rescue Environment Type

Choose which type of Rescue environment you want to create.

Both Linux and Windows PE will recover all Windows operating systems.

● Windows PE 5.0 - Select this option to create Windows PE based recovery media.

The Windows PE environment provides all Macrium Reflect image, restore and cloning functionality. It also supports a wider range of PC hardware than Linux.

○ Linux - Select this option to create a Linux based recovery media.

Linux provides a compact and efficient rescue environment to restore all Windows operating systems.

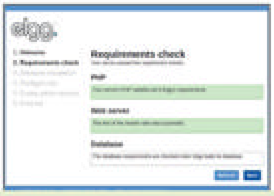
Note: This option enables you to restore your imaged partitions to exactly the same size and postion as they were at the time the image was created.

If you require greater flexibility then choose the Windows PE option above.

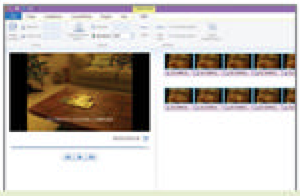
USE MACRIUM REFLECT TO CREATE A BOOTABLE BACKUP IMAGE

Sure, Win7 and Win8 both come with disk cloning tool System Image Backup, to prepare you for when disaster strikes, but its interface isn't the best. Instead download Macrium Reflect at http://bit.ly/1gGwIiJ. It's free for home use, is simple to use, and does everything you need.

MAKE – USE – CREATE



60
Set up your own social network



66
Produce your own stop-motion movie

68
Build the perfect LAN party PC

GRAHAM BARLOW
CONTRIBUTING EDITOR

MACS AND PCs CHEW THE EXFAT

As someone who remembers when 50GB seemed like more storage space than you'd ever need, the ridiculousness of reaching for a 2TB hard drive to store my home videos on never escapes me. And yet, 2TB portable drives are not only available, they're also crazily cheap—often under $100. The problem is, it can be hard to share a portable drive between a PC and a Mac once you go over the 2TB limit. It's down to the file system. The limit for the universal FAT32 file system is 2TB. Formatting larger drives with the standard NTFS or HFS will only result in problems if you try and plug the drive into both types of computer, as without special software it will be read-only. Luckily Microsoft has provided a solution in the form of the ExFAT file system. This is supported by Macs and Windows and there's even limited Linux support. So, if you've got a portable drive bigger than 2TB and want to make sure it can be plugged into any machine, ExFAT is the way to go. It won't be long until we look back at any PC with less than 64TB of hard drive space as inconsequential. Until then, ExFAT is your best friend.

↘ submit your How To project idea to: comments@maximumpc.com

Build Your Own Social Network

YOU'LL NEED THIS

UBUNTU SERVER
We'll help you transform a basic Ubuntu installation into a web server.

ELGG
The freely available open source software that powers our social network (www.elgg.org).

WHEN J. A. BARNES COINED THE TERM "SOCIAL NETWORK" IN 1954, he had no idea that, with the Internet as catalyst, online social networks would change the dynamics of interaction for individuals around the world. As a means of connecting people, social networks can bring together students and provide them with the tools to collaborate on projects, exchange class notes, and even advertise the availability of dorm rooms. Similarly, a corporation could deploy such a social network on its intranet as a virtual water cooler for its employees, and as a means for them to exchange notes and recommend their peers.

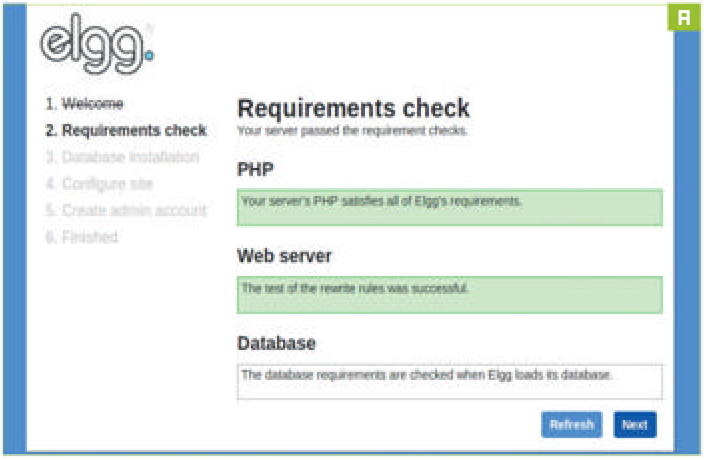
Elgg is a wonderful piece of open source software that's designed to create such niche social networks. Using Elgg, members can have their own blogs, form and join communities, share files, plus collect news and articles using feeds aggregation. The software already powers social networks within several universities and corporations around the globe. In this tutorial we'll help you deploy an Elgg instance on your own infrastructure. **–MAYANK SHARMA**

1 DEPLOY ELGG

Begin by installing the required web server components into an Ubuntu installation (see "Setting Up a LAMP Server," opposite, for detailed instructions). For the rest of this tutorial we'll assume that "/var/www/" is your web server's DocumentRoot directory. When your server's set up, head to www.elgg.org and download the latest version of the software that's available as a zipped archive. Next, unzip and upload it to your server's DocumentRoot directory with the "unzip elgg-1.10.0.zip -d /tmp" and "sudo mv /tmp/elgg-1.10.0 /var/www/elgg" commands.

» With the files in your web server it's now time to create a database for Elgg. The command "mysql -h localhost -u root -p" will prompt you for the password for your MySQL server before invoking its shell. Enter the "create database elgg;" command at the MySQL shell to create the database and then type "exit" to return to your web server's shell. Your MySQL connection settings will surely be different, so make sure you use the correct username, password, and host. You'll also need these later to hook up Elgg to the MySQL database.

» Elgg also needs a folder to house any uploaded files such as user icons. For safety reasons, you should create it outside your DocumentRoot with "sudo mkdir /var/www/elgg-data" and hand over control to the web server with the "sudo chown -R www-data /var/www/elgg-data" command.

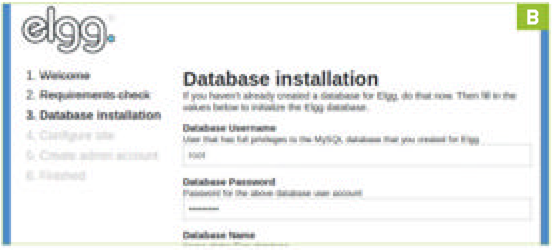


Requirements check
Your server passed the requirement checks.

PHP
Your server's PHP satisfies all of Elgg's requirements.

Web server
The test of the rewrite rules was successful.

Database
The database requirements are checked when Elgg loads its database.



Database installation
If you haven't already created a database for Elgg, do that now. Then fill in the values below to initialize the Elgg database.

Database Username
User that has full privileges to the MySQL database that you created for Elgg
root

Database Password
Password for the above database user account

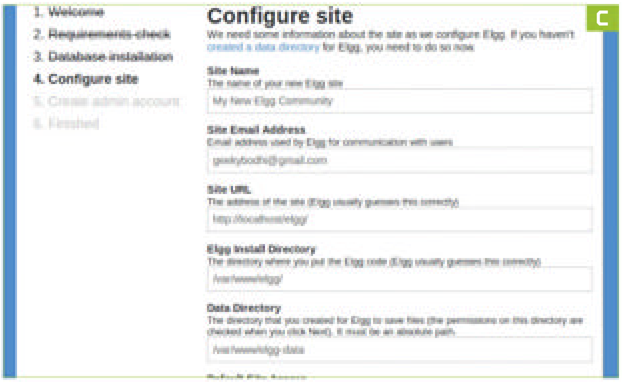
Database Name

2 SET IT UP

You're now all set to deploy your social network. Fire up a web browser and point it to the Elgg installation, such as http://localhost/elgg/. If you're deploying Elgg on a remote server, substitute localhost with the server's IP address. You'll be greeted by Elgg's six-step setup wizard. The wizard will first check whether the server meets all the requirements. If you've set up the server as per the instructions in the box opposite, you shouldn't face any issues (**Image A**). The next step asks you to enter the details of your database server and the database you've created for Elgg (**Image B**). The Database Table Prefix helps you to easily identify Elgg's tables, especially when you share the same database with other web apps as well. You can leave this blank if you're using the database exclusively for Elgg.

» In the fourth step you're asked for some basic information about your social network, such as its name and the administrator's email address (**Image C**). Other information, such as Elgg's URL, install directory, and data directory are automatically picked up by Elgg, but be sure to check them for errors.

» You can also define the default access permission for user-created content from this page. "Public" will show the content to non-logged in users, while "Private" will hide all content behind a login page. Remember you can change these settings, especially the social network's name, even after you've run through the wizard. In the last step you're asked to enter the details of the Elgg installation's administrator. Once you've run through all the steps, Elgg will connect to your database server and populate its database, plus set up a basic social network based on the information it's gathered via the setup wizard.



C

1. Welcome
2. Requirements check
3. Database installation
4. Configure site
5. Create admin account
6. Finished

Configure site

We need some information about the site as we configure Elgg. If you haven't created a data directory for Elgg, you need to do so now.

Site Name
The name of your new Elgg site
My New Elgg Community

Site Email Address
Email address used by Elgg for communication with users
geekybodhi@gmail.com

Site URL
The address of the site (Elgg usually guesses this correctly)
http://localhost/elgg/

Elgg Install Directory
The directory where you put the Elgg code (Elgg usually guesses this correctly)
/var/www/elgg/

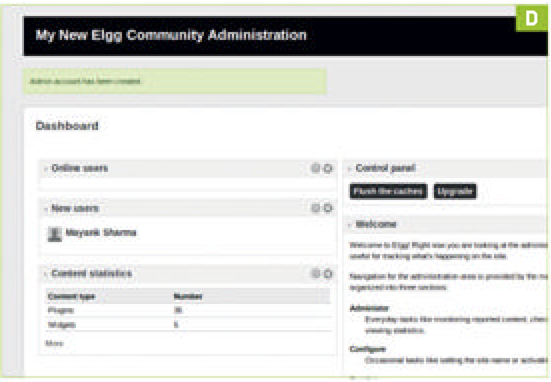
Data Directory
The directory that you created for Elgg to save files (the permissions on this directory are checked when you click Next). It must be an absolute path.
/var/www/elgg-data

3 ADMINISTRATOR DASHBOARD

When you're finished with the setup wizard you can then log into your newly set up social network. Now when you visit http://localhost/elgg, instead of the wizard, you'll be greeted with a login page. Enter the credentials of the admin user you created during the setup wizard to sign yourself into the social network and get you to Elgg's administration dashboard (**Image D**).

» The main administration settings are listed on the right side of the dashboard divided under two broad categories—"Administer" and "Configure." The options under the "Administer" category give you various statistics about the server, plus let you view online users, add new users, and put the network in maintenance mode while you're setting it up. The "Configure" category houses quite a lot of functionality.

» The "Settings" section in particular is useful for altering options that affect the entire Elgg deployment. From here you can change the name of your social network that you specified in the wizard while deploying Elgg. Furthermore, you can also optionally add a description about the network, and even change the default language of the network. In addition to English, Elgg supports over two dozen languages, including French, German, and Japanese.



D

My New Elgg Community Administration

4 CUSTOMIZE APPEARANCE

At this point, your Elgg network is very generic. Click on the "View Site" link at the top of the administration dashboard to view your network as it'd appear to any logged-in user. By default, your network is very bare-bones. You can start by customizing the layout at the top. To change the order of the menu items displayed at the top (such as Activity, Blogs, and Bookmarks), expand the "Appearance" menu under the "Configure" section in the administration dashboard and click on "Menu Items" (**Image E**). On this page you can specify the order of the main menu items by selecting them from the pull-down menu. Any unused items will be available under the "More" drop-down menu. Besides the built-in sections, you can also add a custom menu item by specifying a display name and URL. This is useful for pointing users to another web app outside of Elgg, such as the corporate mailbox.

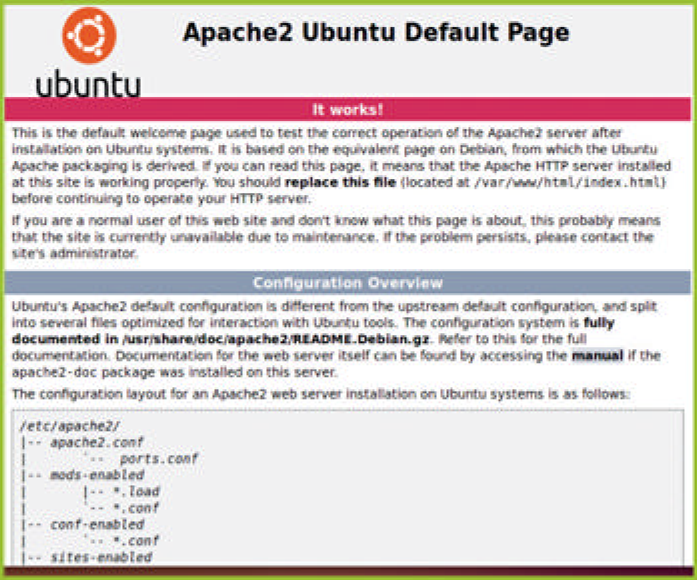
» Next, you may want to modify the default profile fields. If the existing items in the profile (like About me, Brief description, Interests, and Skills) don't work for you, you can easily replace them with something that suits your

SETTING UP A LAMP SERVER

The latest version of Elgg (v.1.10.0) requires MySQL v5 or greater, PHP v5.3.3 or greater, and the Apache web server with support for URL rewriting. To install these components, fire up a terminal and enter the "sudo apt-get install apache2" command to install the Apache web server.

Once that's done, enter "sudo apt-get install mysql-server" to install the MySQL database server. While setting it up, Ubuntu will ask you to specify a password for MySQL's root user. Finally, install PHP and hook it up with MySQL and Apache with "sudo apt-get install php5 libapache2-mod-php5 php5-mysql." Also, remember to enable Apache's rewrite module with "sudo a2enmod rewrite."

Next, turn on the AllowOverride directive, which tells Apache to follow the directives in the .htaccess file instead of the preset ones. Point your text editor to the file "/etc/apache2/sites-available/000-default.conf" and change "AllowOverride None" to "AllowOverride All." Also, to ensure your users can share large files, crank up PHP's maximum upload file size, which defaults to 2MB (upload_max_filesize = 2M). The setting is controlled by PHP's configuration file, "php.ini," which is typically somewhere under "/etc/php5/."



Apache2 Ubuntu Default Page

It works!

This is the default welcome page used to test the correct operation of the Apache2 server after installation on Ubuntu systems. It is based on the equivalent page on Debian, from which the Ubuntu Apache packaging is derived. If you can read this page, it means that the Apache HTTP server installed at this site is working properly. You should **replace this file** (located at `/var/www/html/index.html`) before continuing to operate your HTTP server.

If you are a normal user of this web site and don't know what this page is about, this probably means that the site is currently unavailable due to maintenance. If the problem persists, please contact the site's administrator.

Configuration Overview

Ubuntu's Apache2 default configuration is different from the upstream default configuration, and split into several files optimized for interaction with Ubuntu tools. The configuration system is **fully documented in /usr/share/doc/apache2/README.Debian.gz**. Refer to this for the full documentation. Documentation for the web server itself can be found by accessing the **manual** if the apache2-doc package was installed on this server.

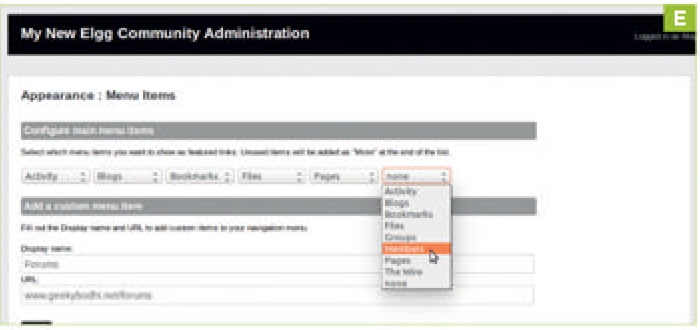
The configuration layout for an Apache2 web server installation on Ubuntu systems is as follows:

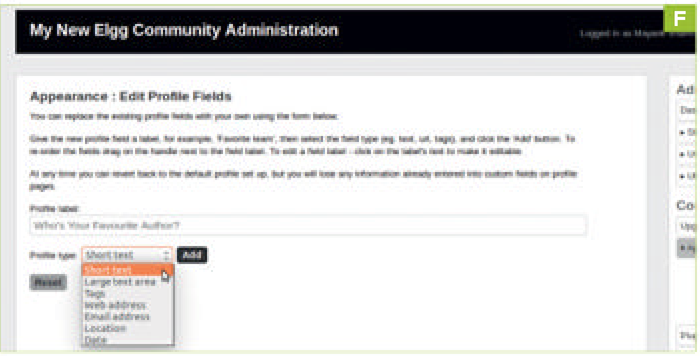
```
/etc/apache2/
|-- apache2.conf
|       `--  ports.conf
|-- mods-enabled
|       |-- *.load
|       `-- *.conf
|-- conf-enabled
|       `-- *.conf
|-- sites-enabled
```

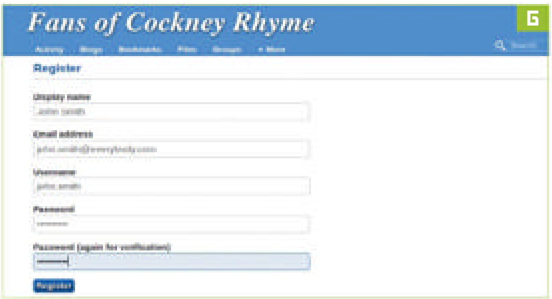
If you get 404 errors while installing Elgg, check the DocumentRoot points to "/var/www" in Apache's configuration file (/etc/apache2/apache2.conf).

requirements. Remember that if you choose to add custom fields they'll replace the default set, which is to say that you can't keep the "Description" field and replace or delete the "Skills" field. Either you keep the default set as is, or replace them completely. You can create your own profile fields via "Appearance → Edit Profile Fields" (**Image F**). The page displays a form that lets you specify the label, for example "Who's your favorite author?" Every label must have one of the seven supported field types, such as Short text, Large text area, Web address, and Location. Repeat the process until you've got all the custom fields you want. Remember to add the fields in the order you want them to appear in the profile.

» For more flexibility in designing a custom profile page you can use the popular "Profile Manager" plugin. Elgg ships with several plugins (and you can download more from the web) that you can enable to add more features and functionality to the stock Elgg experience (see "Go Further With Plugins," below). If you wish to revamp the front page, enable the "Front Page Demo" plugin. You can then head over to the "/var/www/elgg/mod/custom_index directory" which contains the files that make up the front page.







5 USE THE NETWORK

Now that you've set it up, you can start exploring your social network. An Elgg social network is like the other popular networks out there. There's a login page, which also points users to the registration page (**Image G**). You can also manually add users from the administration dashboard. Users have a profile page and a landing page, known as the dashboard. Both areas can be populated with widgets that pull in data from various sources, on and off the network, to show the user's activity.

» You, as the administrator, can set up a default layout for all users that the individual users can then rearrange as per their own preferences and requirements. Users can write blogs, plus create and participate in groups which can have their own blogs and forum boards. They can also host their own pages, upload all kinds of multimedia content in their file repository, and link them along with the text content. Elgg also has a Twitter-like microblog known as The Wire, as well as an impressive access permission system that lets you define parameters for accessing a particular type of content. It offers four parameters—Private, Friends, Logged-in Users, and Public. These self-explanatory parameters define what type of user can view every shared content. Elgg users can also use the built-in messaging capabilities to send messages to other registered users on the network.

» Along with the administrator, all users on the Elgg network also get options to customize their experience. From their dashboard all users can edit their login credentials, flesh out their profiles, and upload an avatar picture. They can also define how they wish to be notified when a certain friend shares new content. However, make sure you spend some time customizing your social network before you throw open the doors.

GO FURTHER WITH PLUGINS

While Elgg has all the features you'd expect from a typical social network, you can extend the core software and add new functionality by enabling plugins. The default Elgg installation ships with over 30 plugins. Of these, several are enabled by default and provide several core features that are mentioned in the tutorial, such as blog, bookmarks, pages, and notifications.

To activate plugins, head to your social network's administration dashboard and select the "Plugins" option from under the "Configure" menu. The page lists all the available plugins, though you can filter them based on their type and priority. Some of the interesting ones you might want to activate are "Site Pages," which lets you create simple web pages; "Tag Cloud" for displaying all tags; and the "Front Page Demo," for customizing the front page.

Furthermore, Elgg has an active plugin community that churns out these useful add-ons by the hundred. In the Elgg world, themes are also treated as plugins. To install a third-party plugin, download and extract it under the "mod/" directory of your Elgg installation, such as "/var/www/elgg/mod/." This will list it under the "Plugins" section in the administration dashboard from where you can activate it like any other plugin.

Remember that they're loaded according to the order they are listed on the "Plugins" page. Make sure any theme plugin is at the bottom of the list. Some of the popular third-party plugins include "Profile Manager" for creating custom profile fields; "Tidypics" photo gallery plugin; and the "Chat" plugin, for adding instant messaging functionality.

Supervise Your Family's PC Usage

YOU'LL NEED THIS

FAMILY SAFETY
The parental controls service is included in Win8/8.1. If you have Win7, you can get some of the features by downloading Windows Live Family Safety, part of Windows Essentials, for free (www.microsoft.com).

WINDOWS 8 INCLUDES A USEFUL SET OF PARENTAL CONTROLS to insulate your children from inappropriate content strewn across the web. It also helps ensure they don't inadvertently compromise the security of your PC by downloading malware and other nasties. You can define when your children can use the PC, which apps they can use, what games they can play, and what kind of websites they can browse. However, before setting it up, you need to make sure you have a password-protected Administrator account so that your children can't simply log in with unrestricted access and turn the parental controls off. Also, create separate Standard accounts for all of your children so that you can set up different restrictions for each person.

To get started, head to the Control Panel and click "User Accounts and Family Safety." Then click "Family Safety" to see a list of the user accounts for which Family Safety can be set up. Windows warns you to set up a password for the Administrator account if one hasn't already been set. You can also add a new Child account. –**MAYANK SHARMA**

1 TURN ON SAFETY

To activate parental controls, select a child's account to open their User Settings. Under the "Family Safety" heading, turn on the "Enforce current settings" option. Similarly, under "Activity reporting," turn on "Collect information about PC usage" to get detailed reports about your child's computer use. Family Safety is now enabled with the default settings.

2 DEFINE TIME RESTRICTIONS

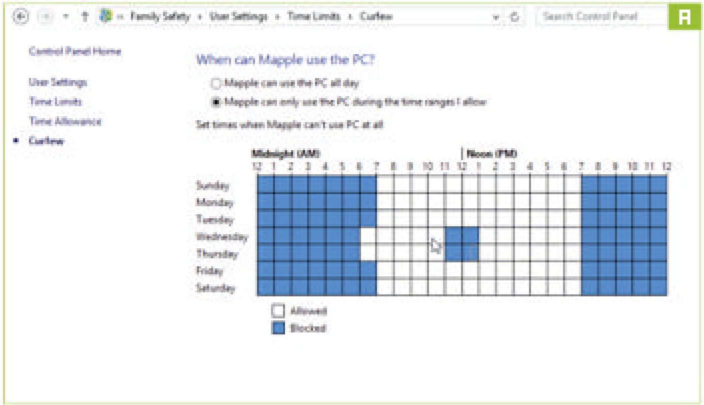
To limit access to the PC, click "Time limits," which gives you two options. Click "Set time allowance" to restrict the number of hours and minutes your child is allowed to use the computer each day. The restrictions can be set for weekdays and the weekend, or independently for each day.

3 SET CURFEW

The "Set curfew" option enables you to define the hours of each day that your child can use the PC. They're shown in a grid, with each square containing two half-hour slots (Image A). Click in a square, or click and drag through several, to turn slots blue and block access. Click again to remove.

4 FILTER WEBSITES

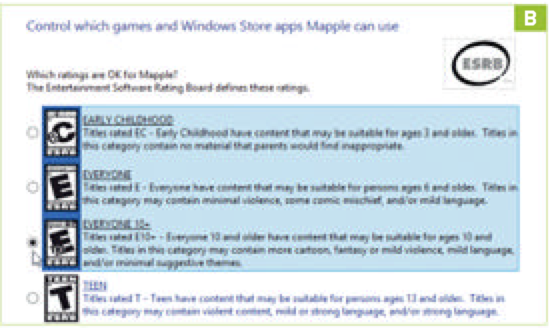
To block websites, click "User Settings" and then "Web filtering." Select the second option to define permitted websites, and then select "Set web filtering level" to open the Web Restrictions window. Here you can choose to block sites broadly, based on their type of content, and also block all file downloads.



When can Mapple use the PC?

○ Mapple can use the PC all day
● Mapple can only use the PC during the time ranges I allow

Set times when Mapple can't use PC at all



Control which games and Windows Store apps Mapple can use

Which ratings are OK for Mapple?
The Entertainment Software Rating Board defines these ratings.

○ EARLY CHILDHOOD
Titles rated EC - Early Childhood have content that may be suitable for ages 3 and older. Titles in this category contain no material that parents would find inappropriate.

○ EVERYONE
Titles rated E - Everyone have content that may be suitable for persons ages 6 and older. Titles in this category may contain minimal violence, some comic mischief, and/or mild language.

● EVERYONE 10+
Titles rated E10+ - Everyone 10 and older have content that may be suitable for ages 10 and older. Titles in this category may contain more cartoon, fantasy or mild violence, mild language, and/or minimal suggestive themes.

○ TEEN
Titles rated T - Teen have content that may be suitable for persons ages 13 and older. Titles in this category may contain violent content, mild or strong language, and/or strong language.

5 RESTRICT APP USAGE

Head back to User Settings, click "Desktop app restrictions" and select the second button to define the apps the user can open. The page now lists all installed apps. Tick the box next to an entry to allow the user to access that app. Any apps that aren't selected will be blocked by default.

6 BLOCK GAMES

To restrict access to mature games, head back to User Settings and click "Game and Windows Store app restrictions." Again, select the second option to define what the user can open, and then click "Set game and Windows Store ratings." This shows a list of game ratings broken down by age (Image B). Your child can only open games rated as suitable for up to the age you pick.

7 VIEW REPORTS

That's it. Your children will not be able to log in during a blocked time slot, nor can they run blocked apps or visit blocked websites. To view their activity, head to their User Settings window and click "View Activity Reports" on the right-hand side of the window. These show when they've used the PC; the websites, apps, and games they've used the most; and pages blocked.

Safely Clean The Registry

YOU'LL NEED THIS

AUSLOGICS REGISTRY CLEANER
Download the lightweight cleaning tool from www.softpedia.com.

LET'S BE HONEST. We're not big fans of Registry cleaning tools. Through the pages of Support Squad we've seen first-hand the damage they can do to perfectly functioning Windows systems. They're often billed as a magic cure for problems, or promise performance improvements, but if you scan blindly and let a Registry cleaning tool simply delete everything it finds, you'll eventually run into trouble—and you won't notice any speed boost either.

Despite all this, Registry cleaning tools *can* help fix problems by tracking down rogue entries and deleting them. The trick is knowing how to use them carefully. In this tutorial, we'll show you how to selectively search for, analyze, and remove the right entries. Just as importantly, we'll also reveal how to put them back again should your clean-out create more problems than it solves. –NICK PEERS

1 INSTALL PROGRAM

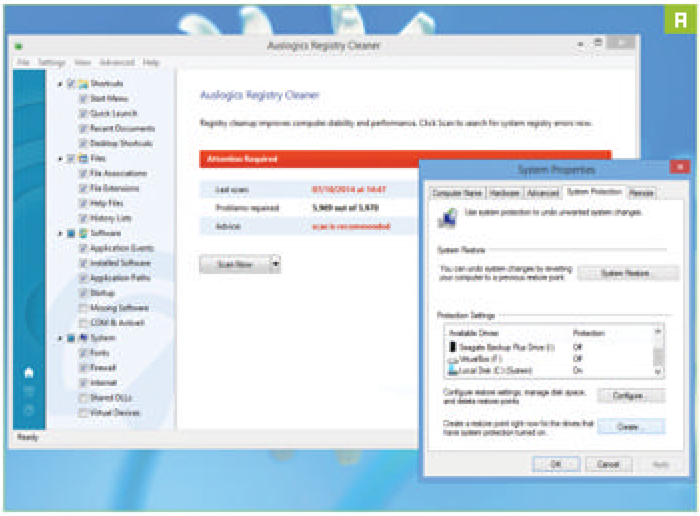
First, install Auslogics Registry Cleaner after downloading it, for free, from www.softpedia.com. During installation you'll be prompted to install Auslogics BoostSpeed alongside it. We recommend unticking this box. The next screen will offer you additional programs—make sure "Custom install (advanced)" is selected, with no additional boxes ticked, to skip installing them all. Click "Next" and the program will install.

2 TAKE PRECAUTIONS

Before proceeding, make a System Restore point—open the Start menu or press Win-Q to open the Search charm in Windows 8. Type "system restore" and click "Create a restore point" under Settings. Click "Create," give your Restore point a suitable name and click "Create" again to set up a fail-safe backup which you can restore should it prove necessary [**Image A**].

3 PRE-SCAN CHECKLIST

Switch back to Auslogics Registry Cleaner, then open the Settings menu to verify "Back Up Changes" is ticked. The left-hand panel reveals which areas of the Registry have been selected for scanning—right-click this column and choose "Check Safe Only" to ensure only safe areas are ticked for now. Once done, click the "Scan Now button and wait while the scan is performed.



4 RESULTS OVERVIEW

Don't be alarmed at the hundreds or even thousands of "errors" it finds—many of these can be left safely in place without any impact on your computer's stability or performance. The results divide these into their parent categories; again, don't worry about the levels of severity assigned to each section—remember that most of these errors have no detrimental effect.

5 EXPLORE IN DEPTH

Use the annotation opposite to help identify problem entries. Most entries should yield some clue to their origin. Look for references to a specific program, or click the "Google it" button to perform a search using that Registry key or value, which may throw up people with similar problems and—if you're really lucky—potential solutions to try.

6 SELECT ALL AND REPAIR

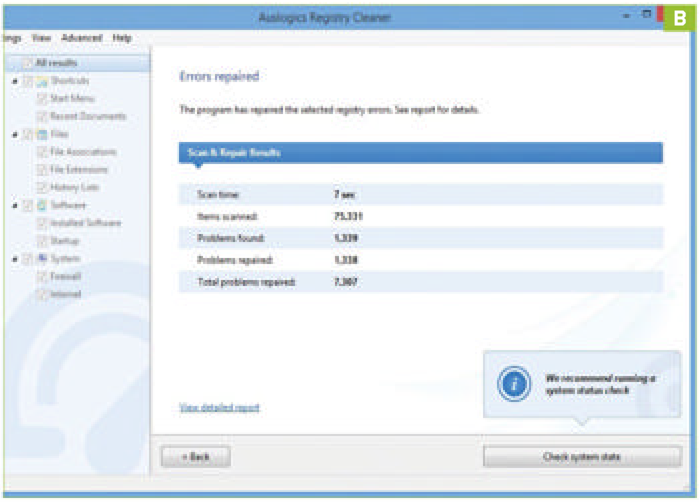
By default, all problems are selected—clicking "Repair" removes them all. If you're unable to identify a specific Registry entry that you believe is causing your problem you could—with some risk—try removing them all [**Image B**]. Click "Repair," then reboot and analyze to see if the problem has gone. If it hasn't, or other problems emerge, jump to step nine to restore the backup.

7 BE SELECTIVE

Alternatively, right-click "All results" and choose "Uncheck all" to select nothing by default. Now manually place a tick next to the entries you wish to remove. When you're done, verify "Back Up Changes" is ticked, then click "Repair" to remove only those entries you've selected. After the repair completes, click "View detailed report" to see exactly what was deleted, if necessary.

8 SEARCH FOR REGISTRY KEYS

Select "View → Find Registry Keys" to perform a manual examination of the Registry for keys to potentially delete. Use the "Filter" button before clicking "Search" to restrict your search. Note that Auslogics Registry Cleaner provides no indication of whether a key is a problem or not; it simply returns all results [**Image C**]. Manually select entries to delete, then "Clean up."


B
Auslogics Registry Cleaner
ings View Advanced Help
All results
Shortcuts
Start Menu
Recent Documents
Files
File Associations
File Extensions
History Lists
Software
Installed Software
Startup
System
Firewall
Internet
View detailed report
< Back
Check system stats

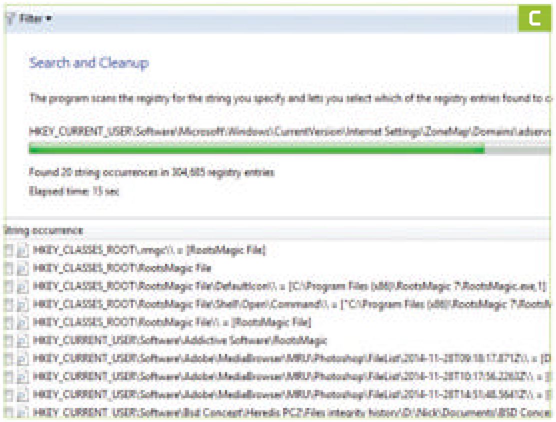
Errors repaired

The program has repaired the selected registry errors. See report for details.

Scan & Repair Results

Scan time:	7 sec
Items scanned:	75,331
Problems found:	1,339
Problems repaired:	1,338
Total problems repaired:	7,387

We recommend running a system status check


Filter ▾
C
String occurrence

Search and Cleanup

The program scans the registry for the string you specify and lets you select which of the registry entries found to c

HKEY_CURRENT_USER\Software\Microsoft\Windows\CurrentVersion\Internet Settings\ZoneMap\Domains\adserv

Found 20 string occurrences in 304,605 registry entries

Elapsed time: 15 sec

```
HKEY_CLASSES_ROOT\.rmgc\\ = [RootsMagic File]
HKEY_CLASSES_ROOT\RootsMagic File
HKEY_CLASSES_ROOT\RootsMagic File\DefaultIcon\\ = [C:\Program Files (x86)\RootsMagic 7\RootsMagic.exe,1]
HKEY_CLASSES_ROOT\RootsMagic File\Shell\Open\Command\\ = ["C:\Program Files (x86)\RootsMagic 7\Rootsh
HKEY_CLASSES_ROOT\RootsMagic File\\ = [RootsMagic File]
HKEY_CURRENT_USER\Software\Addictive Software\RootsMagic
HKEY_CURRENT_USER\Software\Adobe\MediaBrowser\MRU\Photoshop\FileList\2014-11-28T09:18:17.871Z\\ = [D
HKEY_CURRENT_USER\Software\Adobe\MediaBrowser\MRU\Photoshop\FileList\2014-11-28T10:17:56.226Z\\ = [
HKEY_CURRENT_USER\Software\Adobe\MediaBrowser\MRU\Photoshop\FileList\2014-11-28T14:51:48.564Z\\ = [
HKEY_CURRENT_USER\Software\Bsd Concept\Heredis PC2\Files integrity history\D:\Nick\Documents\BSD Conce
```

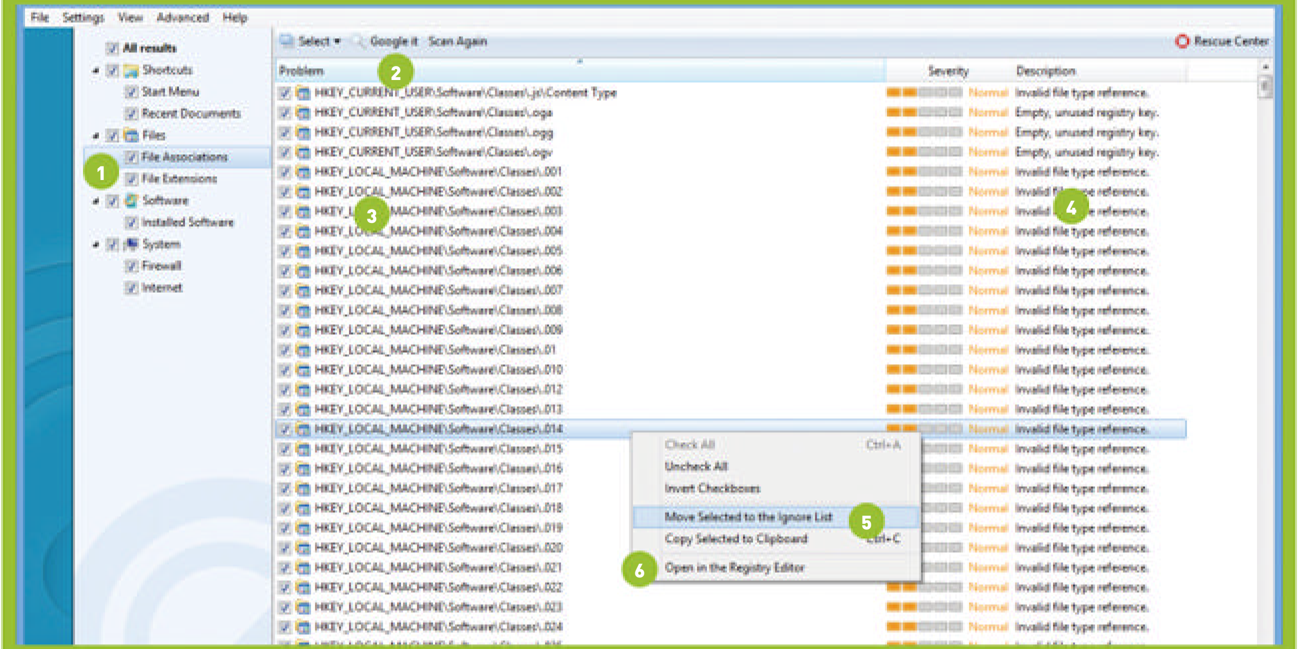
9 RESTORE KEYS

Should you run into new problems, select "File → Rescue Center" to browse available backups and Restore points. Start by right-clicking your most recent backup and choosing "Restore"—click "Yes" to restore all deleted entries from that backup (you can't choose single entries). If this doesn't work, select "Restore Points" and your System Restore file.

10 REGISTRY CLEANING MADE EASY

Armed with these tips, you should now be able to safely remove Registry entries on your PC whenever the need arises. Advanced users have the option to go even further and include potentially more "dangerous" sections of the Registry, including "Missing Software" and "Shared DLLs," when scanning for any problems. Note, however, that indiscriminately cleaning these sections could cause major problems on your PC, so proceed with plenty of caution.

SPRING CLEAN


File Settings View Advanced Help
All results
Shortcuts
Start Menu
Recent Documents
Files
File Associations
File Extensions
Software
Installed Software
System
Firewall
Internet
Select ▾
Google it
Scan Again
Rescue Center
1
2
3
4
5
6
Check All Ctrl+A
Uncheck All
Invert Checkboxes
Move Selected to the Ignore List
Copy Selected to Clipboard Ctrl+C
Open in the Registry Editor

Problem	Severity	Description
☑ HKEY_CURRENT_USER\Software\Classes\.js\Content Type	Normal	Invalid file type reference.
☑ HKEY_CURRENT_USER\Software\Classes\.oga	Normal	Empty, unused registry key.
☑ HKEY_CURRENT_USER\Software\Classes\.ogg	Normal	Empty, unused registry key.
☑ HKEY_CURRENT_USER\Software\Classes\.ogv	Normal	Empty, unused registry key.
☑ HKEY_LOCAL_MACHINE\Software\Classes\.001	Normal	Invalid file type reference.
☑ HKEY_LOCAL_MACHINE\Software\Classes\.002	Normal	Invalid file type reference.
☑ HKEY_LOCAL_MACHINE\Software\Classes\.003	Normal	Invalid file type reference.
☑ HKEY_LOCAL_MACHINE\Software\Classes\.004	Normal	Invalid file type reference.
☑ HKEY_LOCAL_MACHINE\Software\Classes\.005	Normal	Invalid file type reference.
☑ HKEY_LOCAL_MACHINE\Software\Classes\.006	Normal	Invalid file type reference.
☑ HKEY_LOCAL_MACHINE\Software\Classes\.007	Normal	Invalid file type reference.
☑ HKEY_LOCAL_MACHINE\Software\Classes\.008	Normal	Invalid file type reference.
☑ HKEY_LOCAL_MACHINE\Software\Classes\.009	Normal	Invalid file type reference.
☑ HKEY_LOCAL_MACHINE\Software\Classes\.01	Normal	Invalid file type reference.
☑ HKEY_LOCAL_MACHINE\Software\Classes\.010	Normal	Invalid file type reference.
☑ HKEY_LOCAL_MACHINE\Software\Classes\.012	Normal	Invalid file type reference.
☑ HKEY_LOCAL_MACHINE\Software\Classes\.013	Normal	Invalid file type reference.
☑ HKEY_LOCAL_MACHINE\Software\Classes\.014	Normal	Invalid file type reference.
☑ HKEY_LOCAL_MACHINE\Software\Classes\.015	Normal	Invalid file type reference.
☑ HKEY_LOCAL_MACHINE\Software\Classes\.016	Normal	Invalid file type reference.
☑ HKEY_LOCAL_MACHINE\Software\Classes\.017	Normal	Invalid file type reference.
☑ HKEY_LOCAL_MACHINE\Software\Classes\.018	Normal	Invalid file type reference.
☑ HKEY_LOCAL_MACHINE\Software\Classes\.019	Normal	Invalid file type reference.
☑ HKEY_LOCAL_MACHINE\Software\Classes\.020	Normal	Invalid file type reference.
☑ HKEY_LOCAL_MACHINE\Software\Classes\.021	Normal	Invalid file type reference.
☑ HKEY_LOCAL_MACHINE\Software\Classes\.022	Normal	Invalid file type reference.
☑ HKEY_LOCAL_MACHINE\Software\Classes\.023	Normal	Invalid file type reference.
☑ HKEY_LOCAL_MACHINE\Software\Classes\.024	Normal	Invalid file type reference.

1. CATEGORIES
Auslogics Registry Cleaner divides up the Registry into more meaningful categories to help you focus your searches.

2. GOOGLE IT
Use this to search the web for any references to the selected Registry entry—this could help identify it or reveal a known problem.

3. PROBLEM
This lists either the allegedly problematic Registry entry (key or value) or a file or folder path referred to in the Registry.

4. DESCRIPTION
This field highlights why Auslogics Registry Cleaner thinks the selected value, key, or path is a problem that needs to be removed.

5. ADD TO IGNORE
Choose "Select → Move Selected to the Ignore List" to protect Registry entries you know should be left alone.

6. OPEN IN REGISTRY EDITOR
This option lets you view the selected entry in Registry Editor—you can see related values and keys that may help identify it.

Make Your Own Stop-Motion Movie

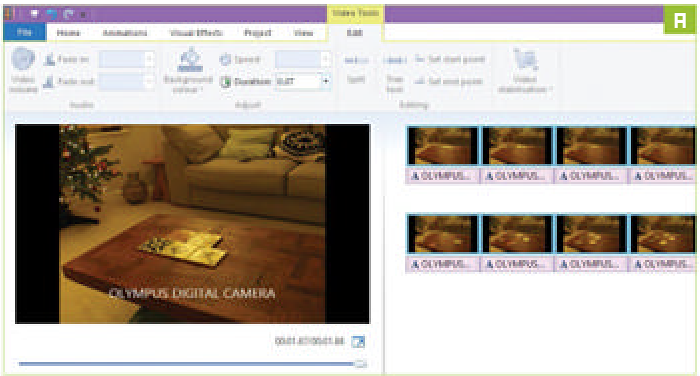
YOU'LL NEED THIS

MOVIE MAKER
The editing software is part of Windows Essentials 2012. Get it at http://bit.ly/1BwQJmg.

CAMERA AND TRIPOD
Steady, consistent snapping will create the best results.

SINBAD AND THE EYE OF THE TIGER, *Jason and the Argonauts*, *Robocop*, *The Evil Dead*—all these movies had something in common: stop-motion, a type of animation technique that originated as early as the late nineteenth century. As the name implies, it's literally a case of stopping motion by breaking it down into a series of discrete steps. By making small incremental movements to an object and taking a picture from the same position each time, you create frames which can later be stitched together in movie-making software.

Once you've joined the frames, it'll look like the object is moving—the more frames you add, the smoother the movement. Creating a stop-motion movie isn't that difficult, but it requires a touch of patience to see one through. It's worth doing, though, because you can create some brilliant effects. –NICHOLAS ODANTZIS



1 SNAP YOUR PHOTOS

You first need to capture the object or thing you're planning to animate. Decide what you want your animation to achieve, then get your camera into position (you'll need a tripod) and each time you move the object a little, take a photo. Once you've finished, upload the photos to your PC.

2 OPEN YOUR FRAMES

Find where you saved your photos, and either Shift and left-click the first and last photo you want to use, or use Ctrl-A to select all the photos in the folder. Now, open Movie Maker—the software you'll be using to make your animation. Download it from http://bit.ly/1BwQJmg and install it. Drag and drop the selected photos into Movie Maker.

3 CHANGE FRAME RATE

The photo frames will have a fixed duration between them, the default being much too slow to make your animation work—it'll look like a slideshow. To change it, select all your frames and click "Edit" in the top menu. In the box next to "Duration," highlight the time and change it to about 0.07 seconds [**Image A**].

4 KEEP EXPERIMENTING

What happens in the movie is up to you, so experiment with the settings. Click the first frame in your video to go to the very beginning of your movie and tap the play button underneath. Movie Maker will show you how your stop-motion video looks with the settings you've used. If you're not happy with what you see, go back to the "Edit" menu and carry on experimenting.

5 SWAP FRAMES

If some of your frames were mixed up in the importing process, you can easily swap them around. Simply left-click a frame and drag and drop it to a new location within the frames already opened. You can also delete multiple frames or add new ones by dragging them onto your project at any time. If you make a mistake at any point, just use Ctrl-Z.

6 REMOVE WATERMARKING

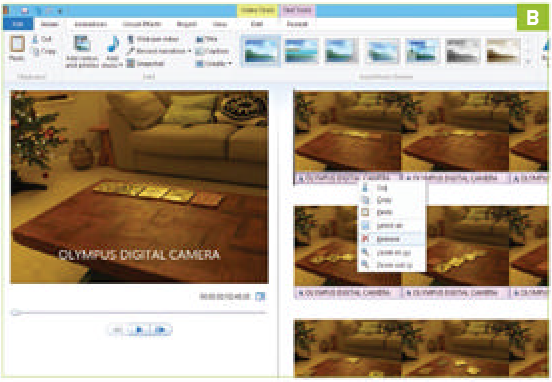
If you opened your frames to find they contain the camera's watermark, don't worry, these can easily be removed. Select all the frames and underneath a single frame you'll see a text box which displays the make and model of your camera. Right-click here and select "Remove" from the menu that appears [**Image B**].

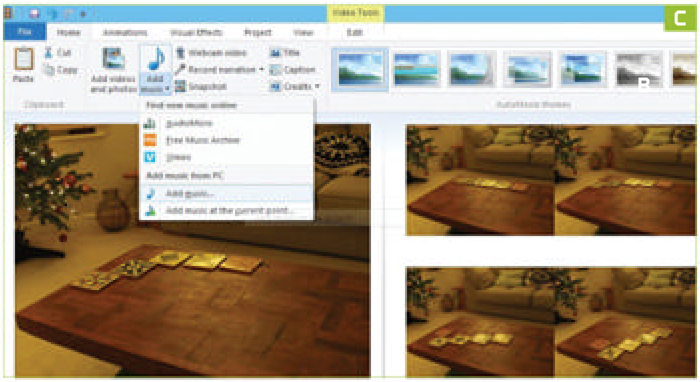
7 MAKE IT DRAMATIC

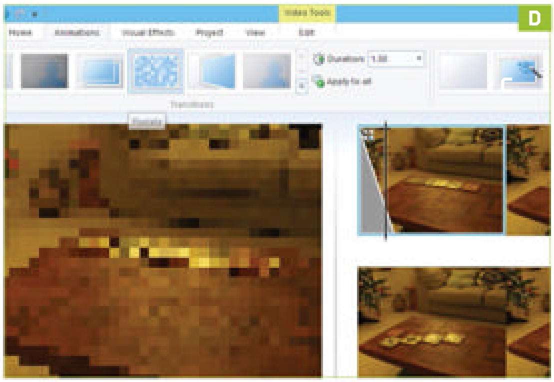
No movie would be complete without a background score, so go ahead and add one. Click "Home" and select "Add music" [**Image C**]. Find the file you want to open and double-click it. Use the "Music Tools" tab to set the start and end point, add a fade in and out, and more. You can add more audio files after the current one is finished.

8 SPRINKLE SOME MAGIC

To give your movie a little polish, you can add a variety of effects. Click the "Visual Effects" tab to change the actual look of each frame, or select them all







to apply it wholesale. If you want to change the way your frames behave, click the "Animations" tab—you can add a selection of transitions or use panning and zooming settings [**Image D**].

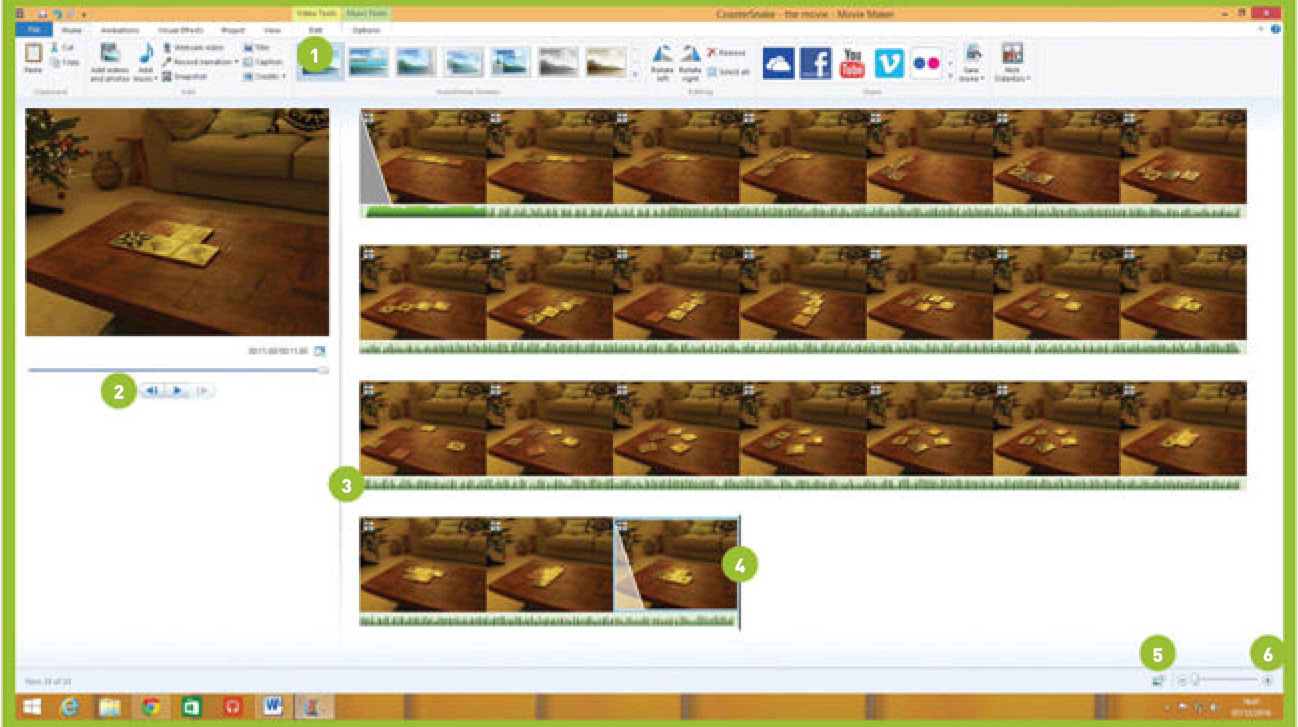
9 WIDE NOT?

If you took the photos on a camera, instead of a phone, the orientation of each image will probably be in the 4:3 format. Movie Maker, however, uses the 16:9 widescreen by default, meaning your photos with be left with black bars on the top and bottom. But don't worry, you can change this as well. Click the "Project" tab and choose "Standard (4:3)" from the Aspect ratio setting. Now your movie will play full-screen.

10 ADMIRE YOUR WORK

That's it, you've made a stop-motion video! To save your animation. Click "File → Save Project," give it a name and hit "Save." If you want to create a movie file that can be played back, go to "File → Save Movie" and choose an option that suits. You can make a movie optimized for Android phones, HD displays, and more. ⏻

LIGHTS, CAMERA, ACTION!



1. EDIT
This tab gives you access to most of the frame editing options, enabling you to change the transition time.

2. PLAYBACK
You can watch a preview of your animation at any point during the creation process by hitting the play button.

3. AUDIO
The green bar represents audio you've added to your video. You can click and drag this to wherever you want it to play.

4. FRAMES
When you import your photos, they appear as frames. You can move them around and change how they appear.

5. THUMBNAILS
If you're working with a lot of frames, you can change their size to see them all at once, or you can zoom in.

6. TIMELINE SCALE
When you want to view your project in more detail, use the timeline slider to adjust the level of zoom.

BUILD IT

TOM MCNAMARA **TECHNICAL EDITOR**

Assembling the Perfect LAN Party Gaming Box

LENGTH OF TIME: **2–4 HOURS** LEVEL OF DIFFICULTY: **MEDIUM**

Get some meaty gaming muscle on the go with this portable powerhouse

THE MISSION

LAST MONTH we built a portable PC featuring the Sapphire ITX Compact R9 285—an AMD Radeon GPU which is roughly on par with a GeForce GTX 960, but short enough to fit in an ITX case. To keep things even-handed, we're going with Nvidia this month. Our Asus GTX 970 DC Mini is at a higher tier of performance and also features twice as much VRAM. (You may have heard recently that the 970's VRAM is divided into two pools, with the smaller one performing more slowly, but it's only a few percentage points different.) AMD has the Radeon R9 290, which performs about the same as a 970, but it requires a lot more power, and there isn't one short enough to fit into an ITX case.

Generally speaking, these compact videocards have changed portable PC gaming a lot. Not all of the systems they go into are made equal, though, so we have to survey the landscape periodically to figure out what's hot and what's not.

LAN OF OPPORTUNITY

THE COOLER MASTER HAF STACKER CASE from last month is a nice option for its modularity and low price, but we decided to go with a cube shape this time, instead of a shoebox. This makes the case easier to balance when it has an integrated handle, like we see on this Corsair Graphite 380T. Thanks to its larger dimensions in the front, the 380T can also fit a 200mm intake fan, though it ships with a 140mm unit in front (and a 120mm exhaust fan in back). You can also fit two 120mm fans on the side, or a 240mm radiator. We, of course, went with the radiator option, specifically the trusty Corsair Hydro H100i. We had one handy, and using the same brand for the CPU cooler and the case tends to cut down on incompatibility.

The 380T can fit a videocard up to 11.4 inches long, but we preferred the shorty GTX 970 to give us some room to breathe. This plugs into an Asus Maximus VII Impact, which is a fancy ITX mobo that uses Intel's Z97 chipset. On CPU duty is the Core i7-4790K, which was the beefiest chip we could put in this mobo. Powering the whole shebang is a gold-rated Cooler Master V550. For storage, we have just a single SSD, since this unit is purpose-built for LAN gaming. The 380T will fit up to two 3.5-inch drives, though, and up to four 2.5-inch drives.

INGREDIENTS

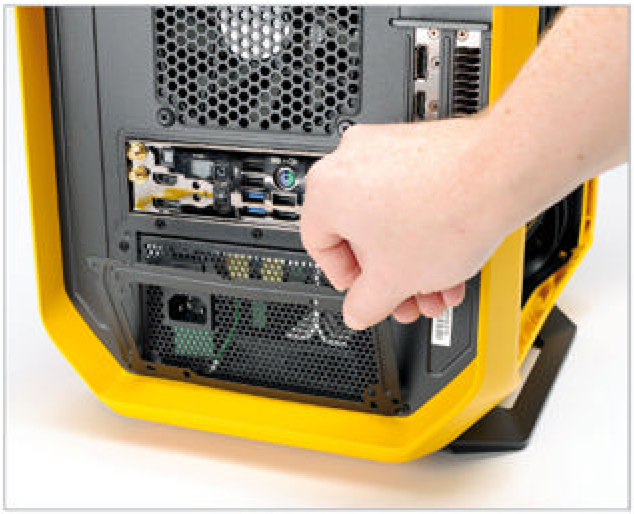
PART		PRICE
Case	Corsair Graphite Series 380T	$150
PSU	Cooler Master V550 550W	$75
Mobo	Asus ROG Maximus VII Impact	$220
CPU	Intel Core i7-4790K	$340
GPU	Asus GTX 970 DC Mini	$350
RAM	2x 8GB Corsair Vengeance Pro	$145
SSD	1TB Samsung 850 EVO	$450
OS	Windows 8.1 64-bit OEM	$100
Total		$1,830

1

METHOD TO THE MADNESS

MINI-ITX CASES, in our experience, all tend to have a number of their own little quirks and unusual deviations. Luckily, however, they generally all make sense when placed in context. This plate, for example, craftily unscrews from the back and allows you to slide in a power supply through the rear of the case. If you're wondering why, well, it's because this case doesn't have enough room to install the PSU from the side.

The 380T can take a PSU up to 180mm long, but you'll have to account for PSU cables, too, if you want to keep hold of the drive cage that's right next to it. That's why we opted for the V550 PSU, which is is 140mm long—we wouldn't recommend pushing very far past 150mm. Connect your modular cables before sliding the PSU in, too, as it's cramped on the other side.



2

ROOM WITH A VIEW

THE TWO SIDE WINDOWS of the 380T come off just by pulling on their handles. As you can see from the top-down photo, though, the mobo is obscured, leading to some tactical considerations. For example, your CPU cooler must be attached to the mobo before they go in the case or you won't be able to screw down the cooler. You can get around it with a short enough screwdriver, but then you don't have much torque.

If you're using a cooler with a radiator attached, you must pull the rad through first. Our 240mm rad also barely fit lengthwise, though the case could accommodate one that's thicker than normal. For the best airflow, we'd recommend pointing the rad's fans on the inside, blowing outward and through it.

3

I'M YOUR BIGGEST FAN

TO POP OFF THE FRONT GRILL, just push its upper-left and upper-right corners until you hear them click, and it's released. The stock 140mm intake fan can be replaced with two 120mm fans or one 200mm fan—the largest option will be the quietest (though you can get high-performance fans at any size). The round holes on each corner are for threading the fan's power cable back into the case. This fan lights up with a white LED, but there's a tiny switch next to the handle in the top of the case that can toggle that off. And just FYI, there's no room in front for another radiator.

4

COOL CUSTOMERS

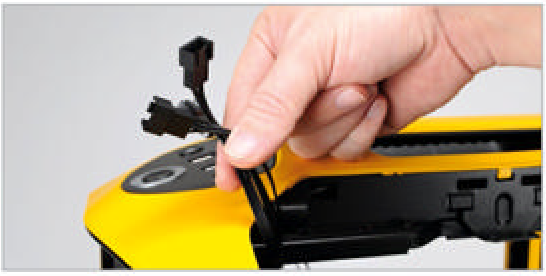
FROM THE OTHER SIDE OF THE CASE you can see just how tightly the CPU cooler's radiator is tucked in there. The tubes also have to be oriented to go into the rad on the far end of the case. If you try to orient the tubes to come out near the motherboard, they will be obstructed by the case's exhaust fan. You could remove the exhaust fan, but you'd sacrifice a lot of airflow. And we didn't notice it at first, but a partially hidden screw also allows you to remove the drive cage, so you could install a pump and a small reservoir if you wanted to do a custom water loop. You can also get pumps that integrate their own res, but a res that small also restricts how much you can cool—you'd be able to do a GPU or a CPU, but probably not both.

5

CONTROL FREAKS

YOU MIGHT WONDER how a Mini-ITX case could cost $150. One of the reasons is the integrated three-speed fan controller. In our scenario, we used this to control the front and rear fan. We could've plugged in the CPU cooler pump as well, but you want to either run that at full speed, or let it use PWM temperature measurements to regulate its own speed. So we plugged the pump into the spare motherboard fan header instead. The cable on the stock exhaust fan is plenty long enough to reach these connectors. There's a fat button on the top of the case with a fan icon on it, and you just press that to cycle through each speed setting.

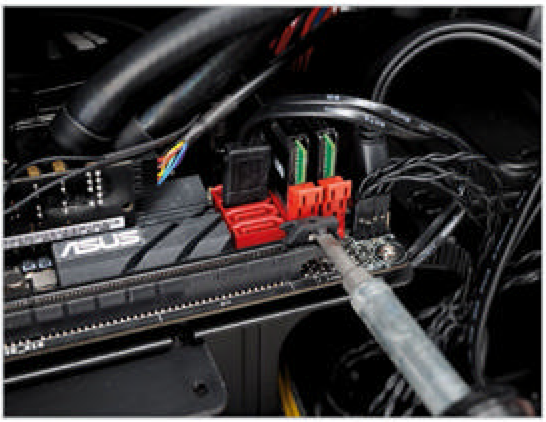
The controller itself gets juice through a SATA power connector, so make sure you've a spare before you install all your SATA-based storage devices. Our CPU cooler also uses a SATA power connector, so we'd need a second cable of that type to install more than two SATA drives.

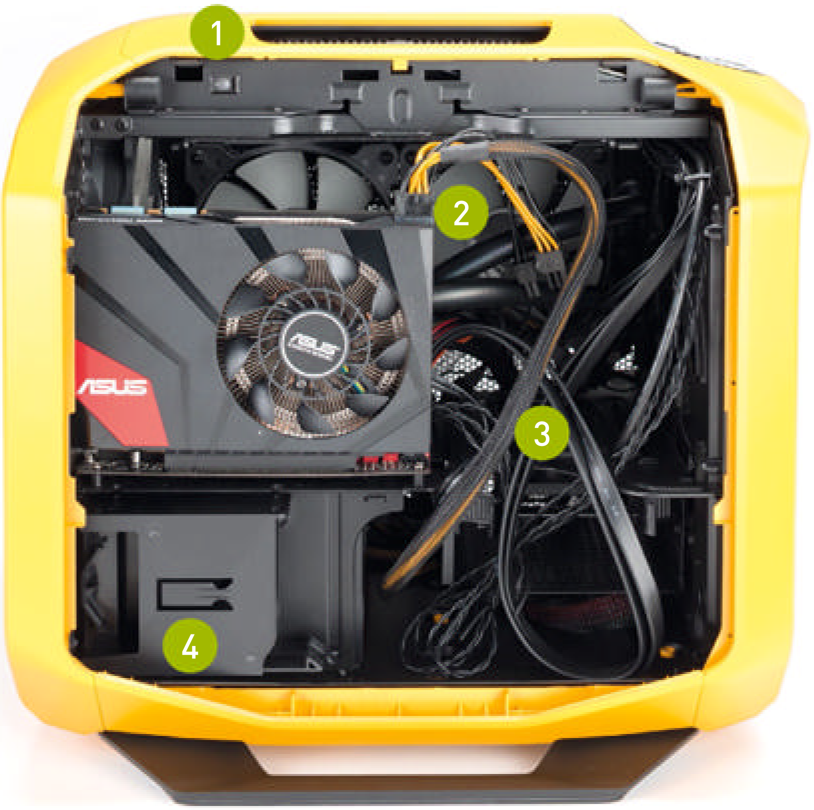


6

POPPING LOCKS

SOMETIMES THE TRICK isn't with the case, but with the hardware inside it. During the course of building a PC, especially one as unique as this one, you will often have to undo a few steps and work your way back. If you aren't familiar with this motherboard, that could prove a little challenging. Most boards use locking mechanisms on the videocard slot to make sure the card doesn't slide out accidentally. This one has an actual spring-loaded latch with a small knob that goes through a notch in the card, rather than a lever-like handle that you can just push out of the way (usually with a spare slot cover).





1 Here's the switch to turn off the LED on the front intake fan. You can't reach it from outside, but the side panel pops off easily.

2 The Asus GTX 970 DC Mini needs only one 8-pin PCI Express power cable to run, so it doesn't need a fancy power supply.

3 You have nearly five inches of space between the end of this videocard and the front of the case, so your cable routing can still be a little relaxed.

4 This is a rotated drive cage that can hold two 2.5-inch drives. We'd definitely recommend right-angle SATA data cables here.

SUNNY SIDE UP

ONE OF THE NICE THINGS about these compact ITX cases is that you can rotate and tip them easily, during and after the build process. The side panels on the Corsair 380T also come off with a flick of the wrist, so gaining access to any angle of the system is a breeze. Speaking of breezes, the large grills on the panels, plus the large front grill on the front and the exhaust fan on the back, make for some serious airflow. We had no trouble keeping this system ventilated. The shorty GTX 970 videocard did make more noise than a card of standard length, so we'd recommend a full-length card if your ears are sensitive to that. Just make sure you stay comfortably under that 11.4-inch limit.

CPU cooler height is also limited to 150mm, which will eliminate a number of tower-style air coolers from consideration. So we'd recommend a closed-loop cooler if you can afford one and are overclocking. It has to be either 120mm or 240mm, mind; the bracket doesn't fit 140mm or 280mm radiators or fans.

We also debated whether to go with an Intel Core i5 or i7 CPU. The latter is more or less an i5 with Hyper-Threading. HT gives you four additional CPU threads, for a total of eight, but it's not like having four extra physical cores. They're more like a simulation. Still, since Direct3D 12 and Mantle let your videocard communicate with multiple CPU threads at the same time (DirectX 11 and earlier versions only talk to one CPU thread at a time), having a lot of threads could boost performance in future games, depending on how they handle this new feature. In the end, we were already spending nearly $1,500 on this system before we'd added the CPU, so adding a $100 premium for the i7 wasn't a big deal.

Either way, you'll get some pretty snappy performance from this system. It took well under 30 seconds to do a full reboot, which helps a lot when installing Windows, Windows updates, drivers, and certain software. Our GTX 970 averaged over 80fps in *Batman: Arkham City* with 4xMSAA and everything else maxed out (though we did disable PhysX). With a whopping 4GHz base clock, our Core i7-4790K whipped through all the benchmarks like a samurai sword (on a core count basis, that is). In fact, it might be time to retire our legendary zero-point system and replace it with something even heavier. ⏻

BENCHMARKS

	ZERO-POINT	
Premiere Pro CS6 (sec)	2,000	2,346
Stitch.Efx 2.0 (sec)	831	739 -12.5%
ProShow Producer 5.0 (sec)	1,446	1,270 -13.8%
x264 HD 5.0 (fps)	21.1	19.2 -9.8%
Batman: Arkham City (fps)	76	85
3DMark 11 Extreme	5,847	4,914 -19%

0% 5% 10% 15% 20% 25% 30% 35% 40% 45% 50%

The zero-point machine compared here consists of a 3.2GHz Core i7-3930K and 16GB of Corsair DDR3/1600 on an Asus Sabertooth X79 mobo. It has a GeForce GTX 690, a Corsair Neutron GTX SSD, and 64-bit Windows 7 Professional.

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REVIEWS

TESTED. REVIEWED. VERDICTIZED.

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Asus Strix DCU2 OC GTX 960

Nvidia's Maxwell generation hits a sweet spot

Squint and you can just about see the owl's face.

ONE OF THE NICE THINGS about PCs is that your budget has a wide range of entry points. If you don't need the heavy lifting of an Nvidia GeForce GTX 980 or an AMD Radeon R9 290X, you don't have to cough up hundreds of dollars for one. Both companies offer a variety of GPUs to fit your budget. Historically, Nvidia's cards ending in "60"—like the 560, 660, and 760—have offered performance in between the premium cards and the more economical choices, putting them in a "Goldilocks zone" of balanced price and performance. Nvidia's latest, the GTX 960, is no exception. With a 128-bit memory bus, a little over a thousand shader cores, and 2GB of VRAM, it's not designed to be a giant leap over the GTX 660. But it's not modest, either.

Let's take a look at the Asus Strix DirectCU II OC Edition of the GTX 960. This mouthful of a card comes overclocked out of the box, and the company claims a 12 percent average increase in performance, versus Nvidia's "reference" model. It features dual fans sitting on top of heatsinks that are fed by several heat pipes, and these fans are made to not spin until the GPU core heats up to 65 degrees Celsius. When it does, the Strix fans are designed to operate quietly, yet still run the chip cooler than the stock version. About 30 percent chillier, in fact. "DirectCU" refers to the copper heat pipes that are in direct contact with the GPU core.

The GTX 960 has a TDP of just 120 watts and only needs a six-pin PCI Express power cable (there are some eight-pin GTX 960s out there, though). Despite that, the Asus card also has an "OC mode" setting that increases its core clock speed to 1,253MHz and its boost clock to 1,317MHz. The default clock speeds of the GTX 960 are 1,126MHz and 1,178MHz, respectively, so it's a sizable jump, but it still stays within the available power envelope of 150 watts (75W from the slot, and another 75W from the cable).

SMOOTH OPERATOR

We tried something a little different this time and ran our benchmarks at 2560x1440 using Dynamic Super Resolution, instead of using an actual 1440p monitor. Technically, DSR uses ordered-grid super-sample antialiasing with a 13-tap Gaussian filter. In more straightforward terms, DSR takes a higher resolution than your monitor can display, squishes it down to fit, and applies a filter to enhance smoothness on the edges of objects in the game world. It can scale up to 3840x2160, also known as "4K," and can stop at points in between, such as 2560x1440. A 1440p monitor has roughly 80 percent more pixels than a 1080p monitor, and it's a common resolution for gamers with deeper pockets. AMD uses Virtual Super Resolution, which is more or less the same thing. *Middle-earth: Shadow of Mordor*, however, didn't cooperate with either DSR or VSR, so 2880x1620 was our closest alternative there.

We pitted this card primarily against AMD's Radeon R9 285, which has roughly the same price point (though this ITX version is a bit higher). The GTX 960 has a 128-bit memory bus, while the 285 has a 256-bit bus, but it doesn't make as much of a difference as you might think, thanks to some clever data compression techniques and improved shader core performance versus Nvidia's older Kepler generation. Whether it was 1920x1080 or 2560x1440, the GTX 960 had little trouble keeping up. In fact, the 960 does a bit better in *Tomb Raider*, which is an AMD-backed game.

The GTX 960's biggest threat is arguably the R9 290, which offers GTX 970–level performance at around $250—though we recommend no less than a 600-watt power supply, because the 290 has a TDP of 275 watts, and it's not bluffing. More recently AMD's "Omega" drivers have made some frankly unexpected strides in performance. Still, the GTX 960 produces pretty much the results it was designed to, at a price that we expected. It doesn't hurt that this Asus Strix version runs super cool and quiet, despite being aggressively overclocked out-of-the-box. **–TOM MCNAMARA**

SPECIFICATIONS

CUDA Cores	1,024
Memory Clock	7,200Mhz (GDDR5)
Memory Bus	128-bit
Interface	1x DVI-I, 1x HDMI 2.0, 3x DisplayPort
Dimensions (H x D x W)	1.6 x 4.8 x 8.5 inches

VERDICT

9

Asus Strix DCU2 OC GTX 960

➕ **ACE OF SPADES** Great price-performance ratio; runs cool and quiet; power-efficient.

➖ **SNAKE EYES** AMD's Omega drivers steal some thunder.

$210, www.asus.com

BENCHMARKS

	Asus Strix DCU2 OC GTX 960	MSI Twin Frozr III GTX 660	Asus GTX 970 DC Mini	Sapphire R9 285 ITX Compact	AMD Radeon R9 290
Tomb Raider (fps)	55	37	**80**	54	**80**
Metro: Last Light (fps)	34	23	47	34	**48**
Batman: Arkham Origins (fps)	45	36	68	51	**75**
Hitman: Absolution (fps)	23	17	39	30	**50**
Middle-earth: Shadow of Mordor (fps)	30	25	**44**	33	**44**
Price (street)	$210	$160	$350	$240	$250

Best scores are bolded. Our test bed is a 3.33GHz Core i7-3960X Extreme Edition in an Asus Rampage IV Extreme motherboard with 16GB of DDR3/1600 and a Corsair AX1200 1,200-watt PSU. The OS is 64-bit Windows 8.1. All games are run at 2560x1440 via DSR, except for *Middle-earth: Shadow of Mordor*, which was tested at 2880x1620.

Alienware Alpha

A great console-sized PC stuck in the alpha stage

The box's aesthetics aren't very flashy, but will look nice sitting next to your TV.

LET'S FACE IT, consoles have the PC beat in the living room. Alienware and the Steam Machines were supposed to change that, but we all know the saga of the Valve delay, while Alienware has decided to release its box early as a small Windows 8.1 PC, dubbed the Alpha. It does an admirable job of attacking the PC's problem areas in the living room, but unfortunately (as the name implies), it's still got some way to go.

Black and small, measuring 2.1 x 7.8 x 7.8 inches, the Alpha is closest in size to Nintendo's Wii U, and we had an easy time lugging it around with four controllers inside a backpack. Speaking of controllers, it comes with a black wireless Xbox 360 controller. Inside the box, the Alpha is running a mobile GPU based on Nvidia's GeForce GTX 860M, the same card used in the HP Omen gaming laptop we reviewed last month. So, since the Alpha has such a unique setup, the Omen seemed the fairest candidate for a zero-point. Its GPU runs at 1,020MHz and has 2GB of GDDR5 VRAM clocked at 1,253MHz. Compared to our ZP, however, the Alpha's performance was a disappointing 11 percent slower in our *Metro: Last Light* and 3DMark 11 benchmarks. It did, however, perform 7 percent better in *BioShock Infinite*. Overall, the Alpha is nowhere near the most powerful gaming PC out there, but it should compete with the next-gen consoles.

TAKING CONTROL

A couple of key base aspects not up to snuff are the 4GB system RAM and the 500GB 5,400rpm hard drive, which ran embarrassingly slowly. Luckily, you can upgrade the RAM to 8GB and upgrade the storage with any 2.5-inch drive. You'll really want to do this.

It's a similar story with the Alpha's i3-4130T CPU, a dual-core desktop CPU running at 2.9GHz. You can upgrade this to a quad-core i5 or i7. And you may want to, considering this i3 gets beat by 30 to 54 percent compared to the Omen's mobile i7-4710HQ processor. Dual-core CPUs are fine for most games, but we'd have preferred a quad-core for a little more future-proofing.

Better is Alienware's interface, which has been wrapped around Win8.1 and can be navigated with a controller. The Alpha UI also allows you to launch directly into Steam Big Picture Mode, and Alienware has even made some nifty tweaks to allow you to use an Xbox controller like a mouse.

One of the Alpha's taglines is that it "combines the freedom of PC gaming with the ease of a console," but the slogan doesn't always ring true. We encountered resolution issues. In *Shadow of Mordor*, for instance, it defaulted to 1280x1024 on our 1080p TV and had no in-game option to adjust it to 1080p. Some games allowed us to adjust the resolution, but blacked out the screen when we cranked it up to 1080p.

At $550, the Alpha isn't cheap, especially when you look at its specs and compare it to the consoles. And it has a bunch of software hiccups to overcome. But when it works, it's awesome. Sure, you could build a cheaper, more powerful system, but Alienware has spent a decent amount of R&D trying to solve the software/UI issues. Yes, it's still in an alpha stage and isn't yet the console-killer it set out to be, but we hope Alienware develops it further. As it stands, the Alpha is a good machine for the PC vet, but not perfect for the console noob. **–JIMMY THANG**

VERDICT 7

Alienware Alpha

➕ **ALPHA** Very portable; brings PC gaming to the living room.

➖ **BETA** Can't upgrade GPU; slow hard drive; only 4GB of RAM; still some bugs to iron out.

$550, www.alienware.com

BENCHMARKS

	ZERO-POINT	
Stitch.Efx 2.0 (sec)	989	1,526 (-35.2%)
Proshow Producer 5 (sec)	1,604	2,305 (-30.4%)
x264 HD 5.0	13.9	6.4 (-54%)
Bioshock Infinite (fps)	50.9	54.4
Metro: Last Light (fps)	49.6	44 (-11.3%)
3DMark 11 Perf	5,071	4,510 (-11.1%)

0% 5% 10% 15% 20% 25% 30% 35% 40% 45% 50%

Our zero-point notebook is an HP Omen with a 2.5GHz Intel Core i7-4710MQ, 16GB DDR3/1600, 512GB SSD, a GeForce GTX 860M, and Windows 8.1. *BioShock Infinite* tested at 1920x1080 at Ultra DX11 settings; *Metro: Last Light* tested at 1920x1080 at DX11 medium quality settings with PhysX disabled.

SPECIFICATIONS

CPU	2.9GHz Intel Core i3-4130T
RAM	4GB DDR3 1600MHz
GPU	Nvidia GeForce GTX 860M
Storage	500GB 5,400rpm HDD
Connectivity	HDMI (out and in), S/PDIF, 3x USB 2.0, 2x USB 3.0, Bluetooth 4.0, 802.11ac
Carry Weight	4lb, 8oz

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Corsair Gaming H1500

Big cans for big sound

The striking black and yellow scheme is a bit of a departure for Corsair.

WE SHOULD WELCOME MODEL numbers back to peripheral naming. They bring a simplicity to the product that would be lost if the marketing department were allowed to take a hit of synthemesc and name this the Pickelhaube XC71-T or the Aural SFX-treme. Numbers have defined PC parts since the 8086. It's good to have them back.

Eight. That's a number too. It's the number of speakers this 7.1 surround sound headset attempts to emulate. It's questionable how much someone with Mark I human ears would notice the difference between 7.1 and 5.1 in their headphones, as the separation of the sound sources is so much smaller than if they're dotted around your room. The technology at work here is Dolby Headphone, digital signal processing witchcraft that crunches a surround sound mix and pipes it to any pair of headphones, retaining a surround-like effect in the process. This can work well in big headphones, as their proximity to your ears is known and the closed-back design helps cut out extraneous noise.

The cans themselves are vast, completely encircling the most BFG-like of ears. They're nicely padded too, the sprung headband never feeling as if it's going to squeeze your head like a teenage pimple. Corsair has made daring and fashion-forward choices for the color scheme, marking it out in bold black and yellow, but with blue lights on the inline remote. A more expensive wireless version omits the yellow for a fully blue outfit.

Naturally, headphones live or die based on their sound quality, and that put out by the H1500s really is pretty good, sounding clear, precise, and remarkably loud. On first plugging them into a USB port and using the Corsair software to test them, we had to turn the volume right down to two. The 50mm drivers are probably the main reason for this, and you have to turn the volume up a long way before you begin to get distortions—up beyond the level our delicate little ears were comfortable with.

The closed nature of the headphones, along with the Dolby cleverness, certainly leads to an immersive soundscape. Standing in Havana in *Assassin's Creed 4: Black Flag*, the sounds of the city swirled around, although those coming from behind weren't really behind, not like they would've been with discrete rear speakers.

LOUD AND PROUD

In *Elite: Dangerous*, the rattle as our Eagle accelerated was pronounced, and we noticed the South African accent of the poor guy giving us permission to land, then watching, face on palm, as we messed it up. Our piloting skills might be questionable sometimes, but at least we heard every scrape and thump. The low frequencies of starship engines were particularly good to hear, as in *Wolfenstein: The New Order* the sound mix tended a bit too far toward the treble, its meaty assault rifles never gaining the thick sound they deserve.

There's a microphone stuck on the front too, a boom design that can be easily swung out of the way when not needed. It's a noise-canceling model, and in our tests caused no problems. But it's a little stiff, so if you need to pull it closer to your mouth you may have issues with it staying put.

It's unlikely that anyone would use these for listening to classical music, unless it was accompanying a low-flying helicopter attack of course, but Corsair has produced a quality headset for gamers, with unsubtle, punchy sound reproduction that's simple to set up, comfortable to wear for long periods, and packs a decent microphone too. **–IAN EVENDEN**

VERDICT 8

Corsair Gaming H1500

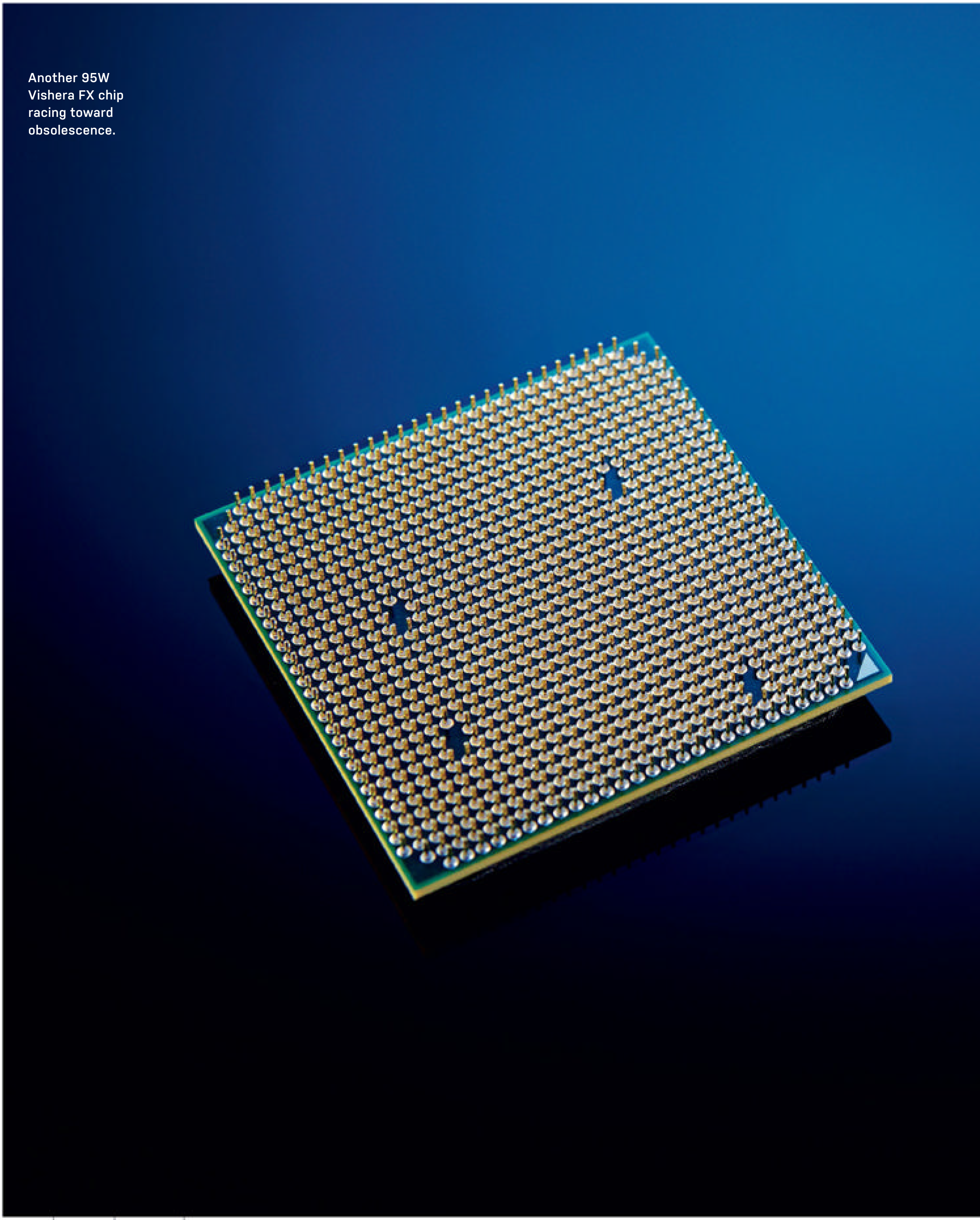
+ OF COURSE Big, comfortable headphones; clever surround sound tech targeted at the gamer.

− NO THANKS Lack subtlety; can be too trebley; make you look like a dork.

$70, www.corsair.com

SPECIFICATIONS

Frequency Response Range	40Hz-20KHz
Driver Size	50mm
Connection Type	USB
Cable Length	3m
Mic	Unidirectional noise-canceling condenser



Another 95W Vishera FX chip racing toward obsolescence.

AMD FX-8320E

A budget octo-core CPU, but is it cheap enough?

WHEN AMD TELLS US it's sending over a new FX-series CPU, we can't help the sudden rush of excitement. It's an automatic response, born of a time when a new AMD CPU had the potential to offer something genuinely competitive. But those days seem long gone. All we get now are half-hearted revisions of increasingly elderly chips.

The FX-8320E is the perfect example of that. AMD released this chip late last year, along with the FX-8370E as a pair of lower-powered octo-core CPUs for the more power-conscious consumer. These two chips use AMD's Bulldozer processor tech and squeeze into a 95W TDP. They're able to do this by utilizing a lower base clock, retaining the same Turbo clock as their non-E brethren. To that end, this FX-8320E is running at 3.2GHz as standard, with the ability to hit 4GHz as needed. The standard FX-8320's clock speed sits some 300MHz higher at 3.5GHz.

So far, so good. For 30W less power you only sacrifice 300MHz of CPU horsepower, which seems like a pretty good trade-off. But the fact these CPUs are still running with an outdated version of the Bulldozer architecture makes them seem more like an afterthought than a proper processor release. In the Kaveri APU, launched a year ago, AMD used the latest revision of Bulldozer, codenamed Steamroller. Its next APU, Carrizo, will use the final Bulldozer revision which is codenamed Excavator. This 95W processor then, using the old Piledriver architecture, is two generations behind AMD's top x86 CPU cores. And it doesn't look like it has any interest at all in shifting the FX range over to the Excavator design, despite the IPC (instructions per clock) boosts that both the Steamroller and Excavator tech have over Piledriver.

THE COST OF SAVING

What's the game with the FX-8320E then? You'd assume that with the focus on hitting a lower TDP, this chip would be looking at small form factor machines, but that 95W TDP is still higher than the 84W Haswell Core i5 processors, even the K-series versions. But then there's the price. At just over $150, this is the cheapest eight-core CPU around—even if you balk at referring to its quad-module design as a full octo-core setup, it still sits as the cheapest, eight-threaded processor you can buy.

In this context, suddenly the FX-8320E looks like a more intriguing purchase. That's especially true if you're sitting on a lower core-count AM3+ chip and feel the need for an upgrade. In performance terms—in both straight CPU and gaming tests—the FX-8320E is evidently behind both the FX-8350 and Intel Core i5-4570, but it's a good $30-50 cheaper than those more powerful chips. And because it's an AMD chip, without the needless limitations imposed on it by overzealous marketing execs (looking at you, Mr Intel K-series), you can get happy with the overclocking. Well, should your chosen chip and board be capable of it anyways.

Our sample wasn't very happy running anything above 4GHz. We got a little more out of it with some voltage tweaks, but not enough to keep it stable on the 970 chipset board we were testing it in. Still, at that speed on all cores it runs mighty close to a stock-clocked, full-fat FX-8350.

For the AMD upgrader then, it's not a bad budget option. If you're looking to build an all-new machine though we'd still struggle to recommend an AMD setup. Even though you're getting eight threads of processing power, a resolutely quad-core, unoverclockable Core i5-4570 will still deliver better CPU performance, and in a smaller power envelope too. The Intel platform is also going to be more up to date and not much more expensive either. While AMD's AM3+ chipsets were queuing up for their pensions, Intel's motherboard chipsets were busy fitting themselves out with native USB 3.0 and PCIe 3.0 support…

And then there's gaming. If you're a PC gamer, your AMD CPU is stealing frames from your graphics card. The difference between the Core i5-4570 and this FX chip is nearly 20fps on average at 1080p settings with the same GPU. And that's with a 50W peak platform power saving over the AMD offering too. Yes, it's initially a cheaper option, but you're paying a different price going the AMD route. **–DAVE JAMES**

VERDICT
7

AMD FX-8320E

➕ **RACING DRIVER** A decent upgrade for an AMD setup; relatively cheap.

➖ **PILEDRIVER** Old, old tech; still more power-hungry than Intel; no native USB 3.0 or PCIe support.

$150, www.amd.com

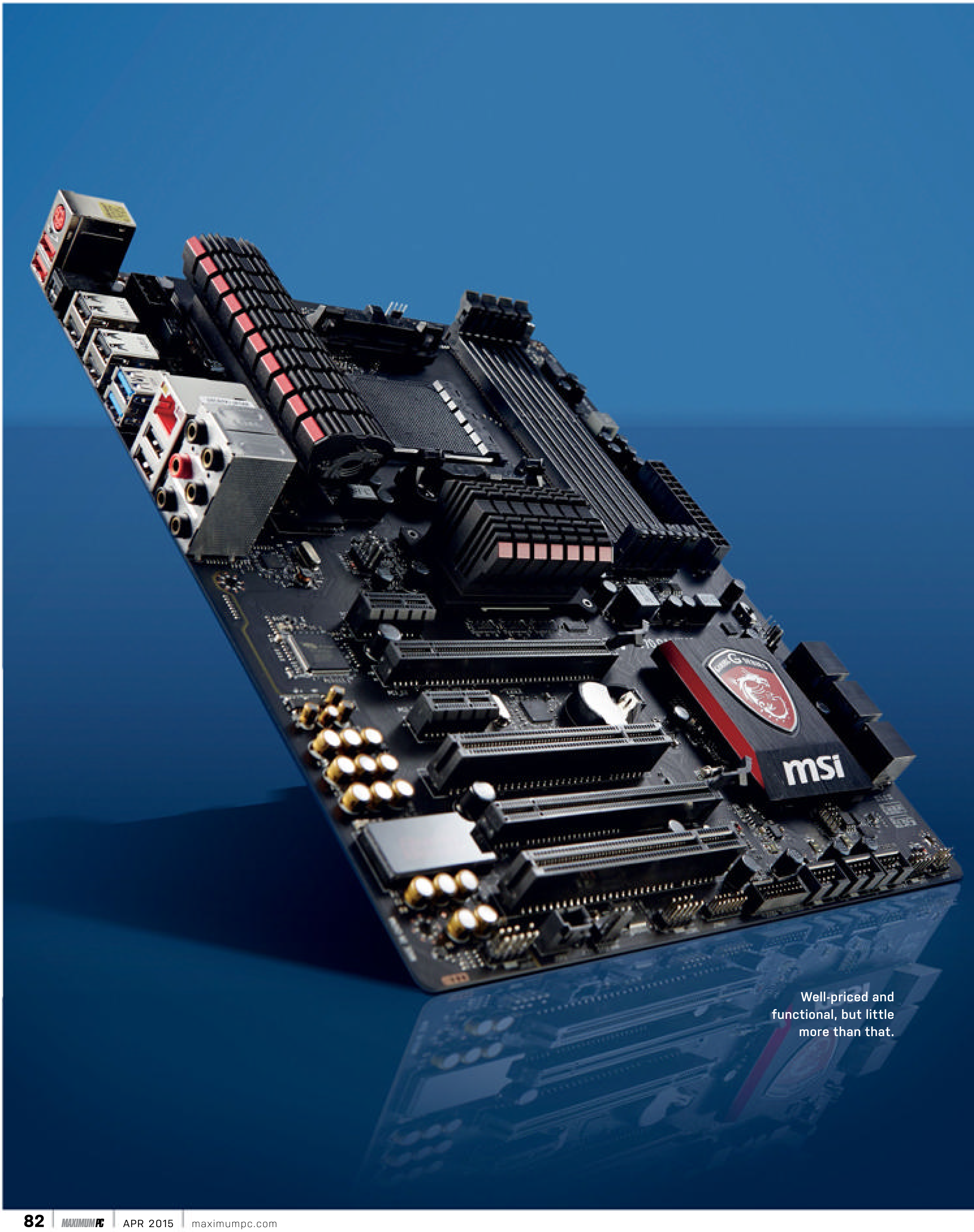
BENCHMARKS

	AMD FX-8320E	AMD FX-8350	Intel Core i5-4570
Cinebench R15 (index)	456	**570**	543
X264 v4.0 (avg fps)	29.41	36.52	**37.09**
Total War: Rome 2 (min/avg fps)	31/50	36/54	**41/62**
Battlefield 4 (min/avg fps)	43/58	45/68	**54/77**
Peak platform power (watts)	173	234	**115**

Best scores are bolded. The AMD tests were done at stock speeds on an MSI 970 Gaming motherboard, with 8GB RAM @ 1,600MHz on Windows 8.1 64-bit. The Intel tests were done on an Asus Maximus VI Hero motherboard with 8GB RAM @ 1,600MHz on Windows 8.1 64-bit. The gaming tests all used a stock GTX 780 Ti running at top settings with 4x AA and at 1080p.

SPECIFICATIONS

Socket	AMD AM3+
Core Technology	AMD Piledriver
Clock Speed	3.2GHz (4GHz Turbo)
Core Modules	4
CPU Threads	8
Lithography	32nm
Cache	4x 2MB L2, 8MB L3
TDP	95W



Well-priced and
functional, but little
more than that.

MSI 970 Gaming

Bargain-priced AMD 970 board anyone? Anyone?

YOU MIGHT THINK THERE'S as much point building a new motherboard based on the elderly AMD 970 chipset as there is making a new transmission for a Model T Ford. But there is some method to MSI's madness. AMD has more or less given up on its FX range of CPUs, we can pretty much all agree, but it has gone and released some "new" chips over the last six months.

We're using the floating punctuation there because none of the latest CPUs are using AMD's latest x86 CPU architecture, sticking instead with the old, inefficient Piledriver design. It did release the 9000 series processors however, with huge 220W TDPs and ambitious base and turbo clocks. Where this latest board makes sense though is with the lower powered E-series chips AMD also released late last year. The FX-8320E and FX-8370E are both 95W parts and that's what MSI has designed its 970 Gaming to support.

As you'd expect from a $105 mobo, the 970 Gaming isn't crammed with features. But it's not as bad as you might think. There are no PCIe storage interfaces, no PCIe 3.0 slots for your graphics cards, and no board-mounted switches for overclocking and the like. No, this is a basic board designed to be dropped into a relatively low-end gaming PC and forgotten about. And to that end it's pretty effective. Those lacking modern touches aren't an issue for a board designed for this price point and the PCIe 2.0 slots are enough for the sort of setup you're going to build with this board too. After all, it's not the available PCIe bandwidth which will hold back your GPU's performance—that will be down to the lackadaisical AMD CPUs you're limited to fitting into it.

ONE FOR THE LOYALISTS

Despite the 970 chipset lacking native USB 3.0 support you do still get a handful of compatible ports, thanks to a pair of VIA chips. SATA 6Gb/s support is there too, offering six little black slots for your storage needs. And even without the OC Genie button on the board itself there's a software function you can access through the BIOS screen. You can get your hands dirty and overclock manually—we got our old FX-8350 CPU up to the same 4.6GHz we managed from an Asus 990FX board, so it's definitely a tempting overclocker.

Inevitably, compared with a 990FX setup, performance is down. Our *Battlefield 4* numbers were around 10fps lower and straight CPU performance was a fair way off too. But considering the 990FX we're comparing it to is still over twice the price, it's tough to complain about it.

What's hard to figure out though, is who we'd think should pick up the 970 Gaming board. For any PC gamer out there, we'd always recommend going for an Intel-based platform. Even if you don't go for a K-series Core i5, a proper quad-core 4570 with a cheap H97 board will outperform the similarly priced FX-8350, let alone the lower-powered E-series variants. And that's in both CPU tests and most especially gaming. MSI's 970 Gaming then is a decent, low-price AMD board. But it's only really a recommendation for the devout AMD followers determined to boycott an Intel upgrade. **–DAVE JAMES**

VERDICT 7

MSI 970 Gaming

+ BOARD GAME Great price; over clockable; decent feature set.

− BORED STUPID Elderly AMD platform; no native USB 3.0 or PCIe 3.0.

$105, www.msi.com

BENCHMARKS

	MSI 970 Gaming	Asus Crosshair V Formula
Cinebench 11.5 (index)	6.14	**6.83**
Cinebench 11.5 @ 4.6GHz (index)	7.04	**7.75**
X264 v4.0 (fps)	36.52	**43.85**
Battlefield 4 (min/avg fps)	45/68	**54/79**

Best scores are bolded. All tests were carried out with an AMD FX-8350 at stock speed (apart from where stated), 8GB DDR3 @ 1,600MHz in Windows 8.1 64-bit. The gaming test used a reference GTX 780 Ti at the highest settings with 4x AA and at 1080p.

SPECIFICATIONS

Chipset	AMD 970
CPU Socket	AM3+
Memory Compatibility	Dual-channel DDR3
Memory Speed	Up to 2,133MHz
GPU Support	2x PCIe 2.0 x16
Multi GPU Support	AMD CrossFireX
Storage	6x SATA 6Gb/s
Back Panel	2x USB 3.0, 8x USB 2.0, PS/2, Optical S/PDIF out, audio in/out, Killer E2205 Gigabit Ethernet

Corsair Graphite Series 380T

Float like a butterfly, look like a bee

PERFORMANCE ENTHUSIASTS like big stuff. Big cases, big videocards, big monitors. But we also enjoy the challenge of fitting a lot into a little. Sometimes it's putting a Porsche engine into a vintage VW Beetle. Other times, it's putting a high-grade gaming machine into a Mini-ITX cube case. Corsair came out with the Obsidian 250D last year, and now it's time for something a little less boxy. The 380T fits the bill, and also delivers a compelling design.

You'll notice one design decision right away. The side panels are tool-less—just pull the handle at the top of the windows and they come off. Almost all of it is a grill, about 10 inches tall and 12 inches wide, so you have some serious ventilation. The front intake grill is about 8.5 inches wide and 9.5 inches tall, and a 140mm fan comes pre-installed. But as you've probably guessed by its sheer dimensions, you can also fit two 120mm fans, or one 200mm fan. You also get a 120mm exhaust fan pre-installed in the rear. Lastly, the power supply gets a grill with a slide-out dust filter. The front and rear grills are also fitted with a fine mesh to keep out dust.

If that's not enough, the 380T has an integrated three-speed fan controller that can connect up to three fans, and it accommodates three- and four-pin fan cables. This gadget is especially handy in an ITX case, because this size of motherboard rarely has more than two fan headers, one of which is reserved for the CPU cooler. The controller is accessed from a button on the front of the case, which also sports two USB 3.0 ports, a large reset button, and a power button.

If you want to add a tower-style CPU cooler, you're limited to a max height of 150mm, but there's a bracket on the right side of the case that will hold a 120mm or 240mm radiator (or two 120mm fans). We installed a Corsair Hydro H100i cooler during testing, and it fit, just. But you do have to install the cooler on the mobo before putting the motherboard in, because the central handle on the top of the case is pretty wide and will block most screwdrivers. It might be better if the handle section was removable, but that could take away the handle's ability to accommodate the case's weight. (Check out this month's "Build It," on page 68, for even more on building into this case.)

YOUR NEW SQUEEZE?

On the bright side, you can fit a videocard up to 11.4 inches long. We'd recommend a shorter one to make your cable routing a little easier; when space is this tight, every square inch counts. But it's nice to have the option to install a full-length videocard.

For an ITX case, the 380T also has some pretty solid storage options. You have two 3.5-inch bays in a removable drive cage that sits in front of the power supply, and two 2.5-inch slots to the left of the power supply. If you need more, an adapter in a 3.5-inch tray will let it accommodate two 2.5-inch drives. We wouldn't recommend a beefy power supply—the practical limit is about 150mm, unless you remove the drive cage. But with space for just one videocard, you won't be pulling much juice anyway. We don't see a scenario where you'd need more than a 600-watt unit.

With a street price of about $140, you could get a pretty slick mid-tower or even a respectable full tower case. So the 380T needs to do some convincing. For what it's worth. we think it's one of the best ITX cases we've seen. You have lots of cooling, space, portability, and eye-catching design (though beauty is in the eye of the beholder). Maybe keep an eye out for a sale on this little bumblebee. **–TOM MCNAMARA**

SPECIFICATIONS

Dimensions (W x H x D)	11.5 x 14 x 15.5 inches
Included Fans	14cm front, 12cm rear
Drive Bays	2x 2.5-inch, 3x 3.5-inch
Max GPU Length	90mm
Max Cooler Height	150mm
Max PSU Length	160mm
Mobo Support	Mini-ITX
Connectors	2x USB 3.0, headphone, mic, three-speed fan control
Weight	12.2lb

VERDICT

9

Corsair Graphite Series 380T

+ HONEY-BAKED HAM Surprising roominess; lots of cooling options; pleasing aesthetics.

– BREAKFAST SYRUP Priced on the high side; handle can obstruct CPU coolers.

$140 (street), www.corsair.com

If you're not a fan of bright yellow, it also comes in white or black.

Small, sleek, and super-speedy.

Samsung Portable SSD T1

The fastest external drive we've ever seen

STORAGE ISN'T SEXY. For all the advances of the last few years, mostly in terms of solid-state drives, it's still difficult to talk about PC storage in any way other than terms of functionality. We all want our PCs to boot from SSDs because of their in-OS speed, but they're not really going to make our games perform better or look more awesome. We're still always going to prioritize a quality graphics card.

But that's not to say things aren't interesting in the world of the SSD. It's one of the youngest, most vibrant areas of computing and has seen constant improvements as new tech, new controllers, and new memory have arrived, boosting performance and reliability, though that's mostly been restricted to internal 2.5-inch drives.

Our first experiences with solid-state storage came with the faithful ol' USB stick and things have barely moved on in anything bar the capacity stakes for years. Of course we did have the switch from USB 2.0 to 3.0 back in late 2009, which hugely boosted the possible bandwidth, but still the overall speed of our external drives has always been a fraction of what you can get out of modern SSDs. And that's still true when you're talking about sticking a speedy SSD in an external USB 3.0 caddy too.

Samsung though has been riding the market mighty hard and are doing a damn fine job of making it very difficult to recommend anyone else's drives. And now they've split out into the external market, too, with this Portable SSD T1.

It's rather tough to get across just how small this drive is. When we first saw the initial images at CES in January, we weren't that impressed. Cut a few days forward to us receiving our sample in the lab and we're slack-jawed and drooling like the magpie-eyed geeks we are. It's almost exactly half the size of a 2.5-inch SSD. But the real kicker is it performs almost as quickly as most SATA 6Gb/s drives.

In the SSD-taxing AS SSD benchmark we recorded average read and write speeds of 420 and 406MB/s respectively. That's seriously quick for an external drive, and the random 4K results were almost as impressive, hitting 23 and 37MB/s for its read/write performance. That's faster than the current SandForce-powered SSDs. You could theoretically run your OS from this drive and see little difference between it and a modern internal SSD.

LITTLE WONDER

This performance is all over a simple, short USB 3.0 cable too. There's no magic to the 5Gb/s USB 3.0 cable either, we hit identical drive performance using a third-party cable from another USB 3.0 external drive. We say this because our worry was that Samsung had hocus-pocused the cabling somehow and we'd be royally screwed losing it, but thankfully that isn't the case.

We're used to using external SSDs over USB 3.0, as we run one of our benchmarking suites from an SSD using a SATA 6Gb/s to USB 3.0 adapter cable and that's provided a speedy storage option that has been a mainstay in our testing suite. Our love has shifted though, as that drive is only half as fast as this super-speedy Sammy drive.

The problem is cost. This 500GB version is $299 and the 250GB version is still around $179, albeit with the same performance. That's a huge amount to pay for external storage. But for the pro-crowd, needing to regularly transfer big files, that spend may just be worth it. –DAVE JAMES

VERDICT 9

Samsung Portable SSD T1

+ SOLID Super-quick; tiny; lightweight; robust.

– FLACID Super-expensive.

$299, www.samsung.com

SPECIFICATIONS

Capacity	250GB, 500GB, 1TB
Interface	USB 3.0, 2.0
Encryption	AES 256-bit
Dimensions (H x D x W)	0.3 x 2.1 x 2.5 inches
Weight	30g
Warranty	Three years

BENCHMARKS

	Samsung T1 500GB	Samsung 850 Pro 512GB (SATA to USB 3.0)
AS SSD Sequential Read/Write Performance (MB/s)	**420/406**	248/239
AS SSD Random 4K Read/Write Performance (MB/s)	**23/37**	16/25
5GB Zip Compression (sec)	**87**	98
30GB File Transfer (sec)	**179**	187
Peak Transfer Speed (MB/s)	**341**	206

Best scores are bolded.

The matte black coating hides psychedelic color-changing abilities.

Corsair M65 RGB

I can shoot a rainbow, shoot a rainbow, shoot a rainbow toooo

WHAT IS THE COMPUTER mouse missing? It already has buttons, wheels, lasers, optics, weights, pulleys, secret chambers for hiding priests, and fluffy patches you can stroke to reduce blood pressure. The bespectacled, white-coated boffins at Corsair, however, think they've struck upon the answer. What the computer mouse needs now, more than anything, is color!

That's right, the thing hidden beneath your hand needs to be more colorful, to be a resplendent peacock advertising its virility in the hope other mice from across the district will come and mate with it. The M65 RGB claims to be able to display 16.8 million colors, which is presumably a rounded-up figure representing the 16,777,216 colors of the 24-bit RGB color spectrum. The human eye, in comparison, can distinguish around 10 million colors.

You can literally make sunshine blaze out of the mouse's backside, as the illumination for the rear Corsair logo spills out of the back of the unit—where the casing has been pared away—and on to your desk. A beam also issues from the front of the mouse, as the wheel illumination leaks out, although at an infuriating angle.

Once you've finished customizing, what are you left with? You get an 8,200dpi infrared laser diode on the bottom of an aluminum unibody that apparently lowers weight and increases rigidity. Although, frankly, if it's your mouse that's lacking rigidity in your hand, then you're doing something very wrong. It is much lighter than it looks, however. Weight distribution, the issue of which keeps some gamers up at night, is said to be "optimal"—but that hasn't stopped Corsair from including three tuning zones on the bottom of the unit for you to adjust the weighting further with a screwdriver.

GETTING TOUCHY FEELY

In the hand, the body of the mouse feels broad and low, with a satisfyingly large contact patch below Mrs Palm. Her five lovely daughters get slightly uneven treatment, however, with the two fingers that rest on the main buttons kept happy but the little finger occasionally left to fidget in space as the body of the mouse vanishes at the wrong point. The edges of the body panels aren't too protrusive, and it's generally a comfortable mouse to use once you've got used to how low it sits.

The M65 has a smooth black coating on its upper surfaces that feels rather luxurious. The lower surfaces have a similar coating that's missed a few turns of the polishing machine, and which are halfway into fine sandpaper territory. It won't be taking any layers of skin off, but it's some of the roughest material we've ever felt on a mouse. This does have its uses—the M65 won't be slipping out of your fingers no matter how much sweat pours down your wrist.

The main buttons, rated for 20 million clicks, feel responsive, while the sniper key that reduces sensitivity so you can pull off smooth headshots falls perfectly under the thumb (if you're a right-hander, no ambidextrousness here). The two buttons above it are less perfectly placed, however, being just a little too indistinct from one another for our tastes. The mouse's greatest component must be its absolute beauty of a wheel: broad and grippy, with absolutely no chance of spinning it too far, it gives just the right amount of feedback as you turn it.

There's a good mouse here under the absurd customization claims. You could easily use it all day without getting hand-fatigue, and the excellent wheel will still be providing manual satisfaction weeks after you start using it. **–IAN EVENDEN**

VERDICT
8

Corsair M65 RGB

➕ **POTENT** Looks great, feels great, moves great; it's got a wheel to die for, if that's not going too far.

➖ **RODENT** This insane amount of color customization in a mouse is simply stupid, stupid, stupid.

$60, www.corsair.com

SPECIFICATIONS

Sensor	Laser
Max Sensitivity	8,200dpi
Programmable Buttons	Eight
Colors	16.8 million
Max response	1,000Hz

Serah's politeness makes us pine for some good old-fashioned misery.

Cutscenes provide a stage for some awful dialogue.

Relentless Assault
Auto-chain

The difficulty is all over the place with some boss battles.

Final Fantasy XIII-2

Time traveling to a bunch of new problems

THE *FINAL FANTASY XIII* TRILOGY is a bizarre series, each game clearly fashioned around the reactions of its fanbase to the one before. *FFXIII* was a cloyingly linear affair with a brilliant combat system, so it follows that direct sequel *FFXIII-2* is so freeform it's sometimes hard to keep up with what you're supposed to be doing. While it's mostly the better game, it comes with a whole host of new problems.

It's set a few years later, and Lightning, moody heroine of the last game, has vanished into Valhalla. It's up to her sister, Serah, and a displaced Valhalla native called Noel to look for her. An initially confusing time travel concept shapes the structure. Using a menu screen-cum-timeline stupidly named the Historia Crux, you can jump between different timeframes of the same environment.

When you're progressing nicely, poking through new time periods, fighting bosses, and exploring, it's classic *Final Fantasy* RPGing and deserves to be lauded. But there are stretches with unskippable battles and dreadful '90s-era switch puzzles that show a developer blatantly out of its depth.

You need a history with *FFXIII* before you even consider buying this. The story is awful, with interminable cutscenes and two lame protagonists. Noel is a walking, talking, spiky-haired nothing, while Serah is so boringly polite she makes a case for why every *FF* hero needs to be a miserable and broken human being (yay RPGs!). But while we didn't enjoy the story, which piles on new characters without any effort to create emotional investment, the world is tonally laidback and pleasant. Towns, explorable environments, and interactive NPCs all make a welcome return.

BATTLE STATIONS

The pacing is better too, letting you start leveling your character's roles right away. The combat, which automates your party's attacks while you change their roles, is functionally identical, but instead of a third-party member, you deploy monsters with their own classes and attacks. It's very flexible. With this excellent combat system, however, comes bad quest design. Chasing sheep to collect wool marks a low point.

Rough stabs at variety don't pay off, such as the intrusive boss fight QTEs—already on their way out when *FFXIII-2* hit consoles in 2012. One poorly judged and irritating platforming sequence feels like it belongs to a different game entirely, while the newly added dialogue options are entirely pointless and only highlight the bad script.

The port brings its own problems. Unlike *FFXIII*'s original 720p-locked release, *FFXIII-2* does at least have a bare minimum of visual options, but the obvious, unaddressed issue is frame rate. It's a little cheeky that the Steam page boasts 60fps when achieving that is so infrequent on even a moderate rig. We'd say *FFXIII-2* is annoyingly slow on a midranged PC, regularly dropping to around 20fps at 1080p with mid-level antialiasing and shadow

Blizzard
Attack
108
823
Serah
Noel

ABOVE RIGHT Noel with another character you won't care about.

TOP The combat makes the story tolerable. Almost.

ABOVE The quick time events (QTEs) felt dated in 2012.

settings, and it hardly looks cutting-edge even then. For those seeking the definitive *FFXIII-2*, this really doesn't feel like it.

FFXIII-2 is an inconsistent sequel, and one we can only recommend to a subsection of the series' audience. It is better than *XIII*. It fixes a lot of its predecessor's problems, focusing on the airtight combat and upping the exploration, but tries its hand at a bunch of new ideas that entirely fail. This feels like a game crafted around a survey of unhappy fans. As such, it's one of the oddest *Final Fantasy* entries to date. **–BY SAMUEL ROBERTS**

VERDICT 6

Final Fantasy XIII-2

➕ **FANTASY:** Better than *XIII*; great combat system.

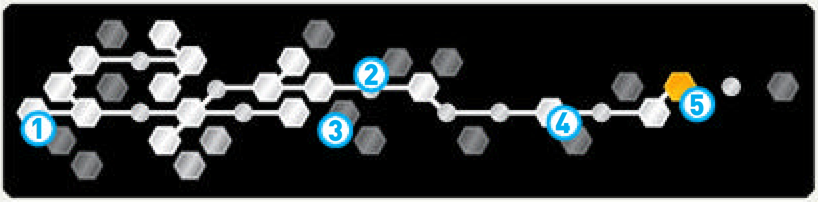
➖ **NIGHTMARE:** Awful puzzles; dated QTEs; terrible story; dull characters.

RECOMMENDED SPECS: GeForce GTX 460, Intel Core 2 @ 2.66GHz, 2GB RAM.

$20, http://bit.ly/1ENhN0v, ESRB: T

CLOCK BOTCHERS

Explaining the Historia Crux and how time travel works in *XIII-2*



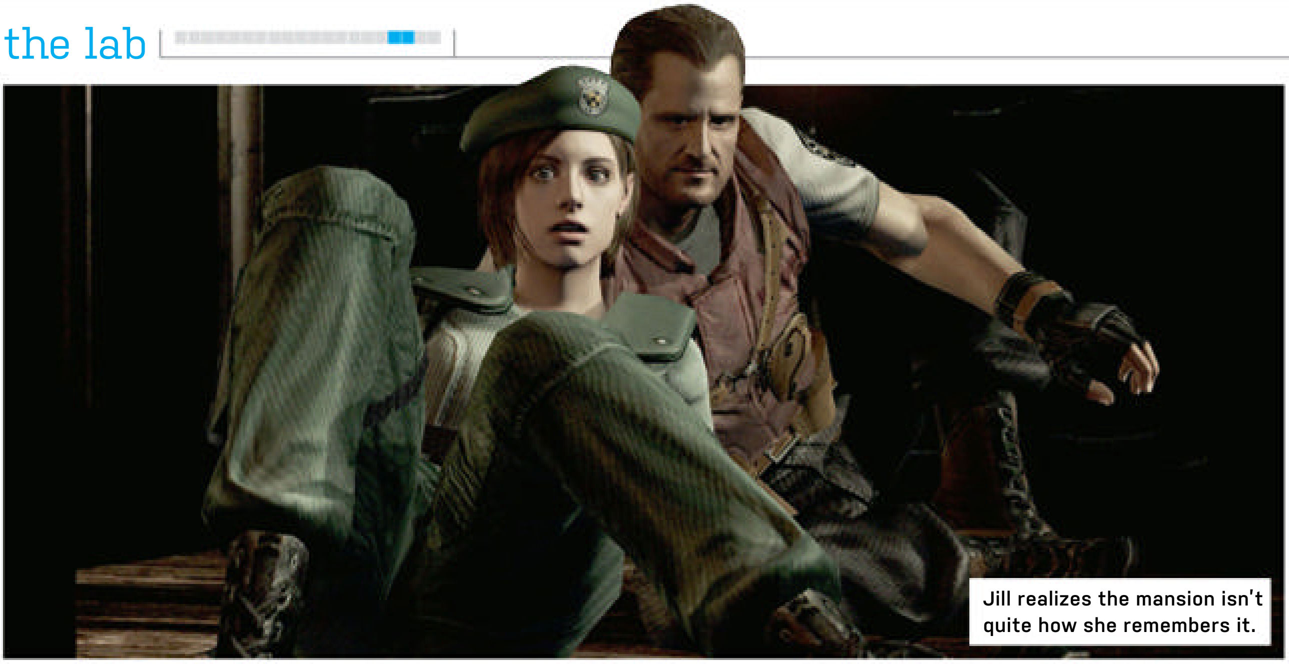
1 Each hexagon represents one specific environment at one specific point in time. Selecting one will warp you to that time and place.

2 This line stretching from the center to the end is the "main" timeline, but in the order of the game, rather than a chronological order of events.

3 The grayed-out hexagons are times and places you need to unlock by collecting fragments and opening time gates—a lot of fetch quests.

4 Many of the hexagons represent somewhere you've been before but at a different point in the timeline, sometimes hundreds of years later.

5 Finally, while the culture shock of landing in a different time and place is pretty cool, none of this makes any sense in the story. Not cool.



Jill realizes the mansion isn't quite how she remembers it.

The locals don't really get the whole personal space thing.

Whatever you do, don't waste your bullets.

Resident Evil HD Remaster

Shinji Mikami's horror classic rises from the dead

WE'RE USED TO FEELING like the center of attention in games, like the whole world revolves around us. But *Resident Evil*'s zombie-plagued mansion doesn't care about you. It's a place where death lurks around every pre-rendered corridor, and if you stumble into one of its sadistic traps or undead denizens, bad luck. It's back to the main menu with you, and you better hope you saved. *Resident Evil* doesn't hold your hand: it rips it off and eats it.

This is a remastered version of a remake of the original 1996 game, which was released for the Nintendo GameCube in 2002. It retains the fixed cameras, rendered backgrounds, and tank controls of Mikami's pioneering survival horror, but mixes a few things up. If you know the Spencer mansion from the PlayStation game inside out, there are plenty of surprises. But if you've never played the original, this is the best place to start. Even though it's 13 years old (and based on a 19-year-old game), it's worth it.

You can play as one of two characters, each with their strengths and weaknesses (see "His and Hers," opposite). There are no respawning items in the haunted house setting, so it becomes a game about management: knowing when to fight, when to run away and conserve ammo, and whether to use a health item now or save it.

Even your saves are finite. *Resident Evil* really is a survival horror game. Every wasted bullet or typewriter ribbon (which are used to save) could come back to haunt you later. Even defeated zombies can be a problem, springing back to life as more powerful "crimson heads." You'll have to burn their corpses to avoid this.

LOW RESI

The remastering isn't as good as we'd hoped. We thought they might have dug the original pre-rendered backgrounds out of some dusty archive and presented them at a higher and previously unseen resolution, but it seems as if they've just added a filter to the existing GameCube files. As a result it doesn't look spectacular, especially on larger monitors, but the lighting and atmosphere make up for it. Light sources in the world illuminate your character as you move past them, which does a surprisingly good job of fooling your brain into thinking these are proper 3D spaces.

The mansion is a wonderfully eerie setting, and the fixed cameras, although archaic, actually add to the tension. The game uses blind corners to great effect, and you'll often hear the groan of a zombie before you see it. This makes you play cautiously as you creep through the dingy corridors. Sometimes the camera will be peering at you through a window or floating above you, which gives you an uneasy feeling of being watched. Rather than being hamstrung by their two-dimensional limitations, the developers have used them to make a really effective horror game.

ABOVE You've got red on you, buddy.

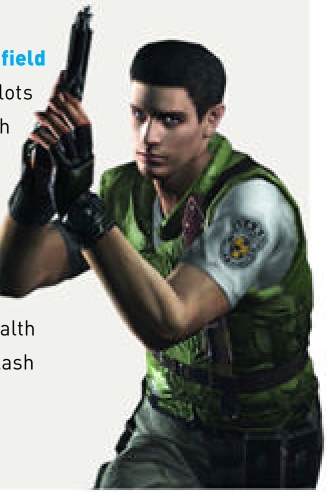
ABOVE RIGHT The fixed camera adds to the tension.

TOP Where's a snake charmer when you need one?

HIS AND HERS

The key differences between *Resi*'s two playable characters

Jill Valentine	**Chris Redfield**
Eight item slots	Six item slots
Starts with gun and lockpick	Starts with knife and lighter
Low health	Deals high knife damage
Can find and keep grenade launcher	Lots of health
Can use stun gun	Can use flash grenades



With hardcore survival games frequently topping the Steam charts, Capcom has picked a good time to revive *Resident Evil*. It's a punishing, but immensely satisfying game, even if the "remaster" isn't as dramatic as the title suggests. If you can't stomach the tank controls there's a new analog option that works well with a controller, but the keyboard and mouse controls are pretty clunky. This was originally designed for a Nintendo console, after all. –ANDY KELLY

VERDICT 8

Resident Evil HD Remaster

➕ **ALPHA:** Genuinely scary, creepy, and very atmospheric.

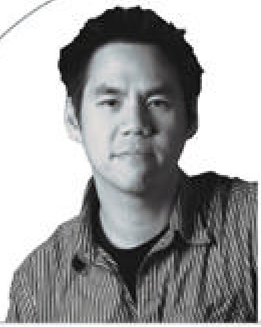
➖ **BRAVO:** Remastering is visually underwhelming; keyboard and mouse controls aren't the best.

RECOMMENDED SPECS: GeForce GTX 560, Intel Core 2 Quad @ 2.7GHz, 4GB RAM.

$20, www.capcom.co.jp/biohd/en, ESRB: M

LAB NOTES

JIMMY THANG **ONLINE MANAGING EDITOR**



Evolution Not Revolution at CES

Luckily, there's still plenty of cool PC stuff

FOR BETTER OR WORSE, I was able to predict pretty much everything at the Consumer Electronics Show (CES) this January—it was more of an evolutionary year than a revolutionary one. We saw a bunch of VR headset knockoffs, self-driving car prototypes, and, as much as it pains us to use the term, a bunch of "The Internet of Things" things.

That said, however, there were a few small pleasant surprises. No, Razer's gimmicky Project Christine from last year's CES never came out, but CyberPower's Trinity PC reminds us of Razer's modular computer... except that it's actually real. It may not be as ambitious, but it's got three separate bays, housing motherboard, GPU, and PSU, respectively. It's definitely a very innovative design in the PC space. While that hunk of metal is big and heavy, we also saw some innovation on the smaller end of the spectrum. Lenovo's LaVie notebook is incredibly light—it feels like a Fisher Price toy. Then there's Intel's Compute Stick, a full Windows 8.1 PC running on an HDMI stick that's the size of a Chromecast. Crazy.

No CES would be complete without iterative design, and that's not always a bad thing. Digital Storm's Aventum 3 is undoubtedly the most beautiful system we've seen so far this year. It's a little smaller than the Aventum 2, but features a quick-release custom-loop water-cooling system. Asus is also trying to up its game with its Asus ROG Swift PG27AQ monitor, which packs a 4K-resolution IPS panel. Did we mention it's G-Sync compatible? If they could make it a touchscreen and up the refresh rate to 144hz, we may not need a new monitor for another decade.

There weren't any crazy surprises at this year's show.

The Vegas show is also a time for wackiness, and Gigabyte's Waterforce cooler is by far the craziest closed-loop water cooler we've ever seen. Arguably the zaniest PC was MSI's GT80 Titan. I mean, MSI actually put a real mechanical keyboard in a gaming laptop.

TUAN NGUYEN

Editor-in-Chief

Working at *Maximum PC*, we're blessed with companies providing the kit we need. But hey, what's the point of buying it when I can just build it, right? So, on a spare Saturday at the office, that's exactly what I did.

I put together a system that's roughly similar to the one I use at home. The specs are: Intel Core i7-3960X, Asus Sabertooth X79, 32GB of Corsair Dominator Platinum DDR3, Samsung 850 Pro 1TB SSD, Nvidia GTX 980, Corsair HX850i PSU, NZXT Kraken X41 AIO liquid cooler, NZXT H440 chassis, Acer XB0 28-inch 4K display with G-Sync, and a Das Keyboard Model S Ultimate.

It sure beats the Macs and Dells that would've been my fate had I gone the "normal" company route!

TOM MCNAMARA

Technical Editor

CES seems to have kicked off a resurgence in the display market, at least on the high end. After years of evolution in the mobile space, us desktop dinosaurs are finally getting some love. For untold aeons, 1080p has been the standard, with some fancier folks bumping it up to 1440p or 1600p. Now we're seeing a convergence of 21:9 ultra-wide screens, G-Sync and FreeSync, 144Hz refresh rates, 4K, IPS panels, and sizes that are usually reserved for TVs. Higher resolutions also demand more performance, so it'll be interesting to see how that plays out. Meanwhile, VR and AR look like they might finally become a real and serious thing, rather than just a passing fad.

First Look:
MSI GT80 Titan

The first gaming laptop with a mechanical keyboard

WE'VE BEEN ASKED MANY TIMES why there aren't any gaming laptops out there with mechanical keyboards, and we've always given the quickfire response that "it would make the laptop too big." Well, the mad team at MSI has decided to totally ignore that notion and work with SteelSeries to incorporate a mechanical keyboard with Cherry MX Brown switches into its GT80 Titan notebook. While this does add to the bulk of an already large 18-inch laptop, beefing the weight up to a hefty 10 pounds, it is being designed from the ground up as a desktop replacement.

If you look above the keyboard, it seems there's a bunch of negative space, but this is actually where all of the components lie. Inside the laptop are two GeForce GTX 980M GPUs in SLI. According to MSI's internal benchmarks, this makes it perform slightly faster than a single desktop 980, so the GT80 does live up to the desktop-replacement moniker in more ways than one.

Another exciting element that MSI hopes to bring over from the desktop world is modularity. Laptops, even of the gaming variety, aren't known to be very modular, but the GT80 will allow you to easily swap out memory and storage via the laptop's quick-release top cover. According to MSI, the company is also working with partners such as Xotic PC and CyberPower to allow you to swap out and upgrade your Mobile PCI-Express Module (MXM) graphics cards, however the company was coy when we asked what users could expect from a future mobile GPU roadmap.

The other specs of the notebook are quite impressive. It features four DIMM slots for up to 32GB of RAM, four M.2 SATA SSDs in RAID 0, and can be outfitted with up to four 512GB SSDs. It will also, of course, be equipped with a mobile Core i7 processor.

Another interesting design choice of the notebook is MSI's decision to place the trackpad to the right of the keyboard, similar to Razer's Switchblade UI used in its 17-inch gaming notebooks. Unlike Razer's offering, however, MSI doesn't intend for users to game with it (for serious gaming, they advise going with a mouse), but it will be able to double as a digital numpad, essentially offering a full-size keyboard. The touchpad also offers haptic feedback to simulate tapping on the real thing.

You'll be able to get your hands on the MSI GT80 Titan by the time you're reading this, starting at $3,300. **–JT**

MSI's GT80 Titan features two GeForce GTX 980Ms in SLI.

GEEK TESTED & APPROVED

Inateck FE2003

It's time to do something useful with your old SSDs.

IF YOU'RE LIKE US, you've been upgrading your solid-state drive capacities as prices have come down on the bigger sizes. This can leave you with several leftover drives that don't have much purpose. Thankfully, there's a cottage industry of inexpensive enclosures that can give your SSD a second lease of life as external USB 3.0 storage. The Inateck FE2003 in particular has support for the USB Attached SCSI Protocol (UASP). In a nutshell, UASP can give a USB 3.0 storage device a serious performance boost, nearly on par with that of an internal SATA III SSD. Most mobos support this feature nowadays, but double-check on the manufacturer's website before you dive in. UASP also might not be enabled by default.

A tool-less enclosure is probably your best bet, but we don't mind the two screws that hold in the FE2003's tray, and this enclosure even comes bundled with a small screwdriver—plus a sturdy USB 3.0 cable, a separate power cable that plugs into a USB port (though you shouldn't need the second cable for most drives), and even a black flannel bag to carry everything in. It's also not as thin as most other drive enclosures, but the glossy black aluminum casing feels nice, and there are even grills on either side to help dissipate heat. The extra width also gives the unit enough room to accommodate a regularly-shaped USB port, so you can use a standard USB 2.0 cable in a pinch. **–TM**

$17 (street), www.inateck.com

LETTERS

WE TACKLE TOUGH READER QUESTIONS ON...

> New Intel Chips
> Mobile GPUs
> Touchscreen Monitors

Broadwell Broadcast

I've been a loyal reader since the *boot* days. I'm wondering why the magazine hasn't covered Broadwell or Skylake very much. I'm impatiently waiting to upgrade my six-year-old i7-920 to the new 14nm technology. It would be nice if you guys covered the debate of whether to buy Skylake or Broadwell, and give us your best estimate of when the chips will be released. **—John Neggia**

TECHNICAL EDITOR TOM MCNAMARA RESPONDS: Hi John, we haven't talked about Broadwell or Skylake too much because information has been thin on the ground and mostly rumor. But, good news, that's about to change! Make sure you pick up next month's *Maximum PC* for a full report on Broadwell and Skylake and how they'll fit in on the desktop. We do know that Broadwell will plug into existing motherboards design for Haswell, while Skylake will support DDR4 and be incompatible with current Intel motherboards. Pick up our May issue for all the answers.

Dream On

I'm a big fan of *Maximum PC* and although I don't always understand all the magic you do, I still enjoy reading about the adventures you have building the Dream Machines. I have a proposal for a true Dream Machine. It all stems from my anger that there are so many good games available only for consoles. Why not make a Dream Machine that plays all game formats (PS4, Xbox, PC) on one machine. Now, that would be a true dream! I thought such a thing might be possible now with the consoles switching hardware to x86 CPUs. I guess this subject has been discussed before and deemed impossible, but it's fun to dream. **—Ian Hayes**

ONLINE MANAGING EDITOR JIMMY THANG RESPONDS: Hey Ian, we hear you. There are some great exclusive console games out there. Unfortunately, even though the current-gen consoles are both built on the x86 architecture, they still use custom hardware that we can't replicate with off-the-shelf parts. Both Sony and Microsoft have invested heavily in their respective console's operating systems. We're

[NOW ONLINE]

MICROSOFT'S NEW HOTNESS: WE TAKE HOLOLENS FOR A SPIN

When Microsoft first revealed its augmented reality HoloLens headset at the Windows 10 launch event, we thought it was nothing more than the company jumping on the head-mounted display bandwagon. But after trying four demos, our jaws were bumping the floor.

It may not be VR, but it doesn't try to be. Microsoft is pitching the device as "your world with holograms," and that description couldn't be more apt. For more on the device, and what we thought of it, read our in-depth eyes-on here: http://bit.ly/MPC_hololens

A prototype sample of Microsoft's HoloLens headset.

↘ submit your questions to: comments@maximumpc.com afraid nothing short of a brilliant hack would let you get close to building an Xbox One or PS4. Even then, we're sure it would be a buggy experience at best. Luckily, the PC has the best library of games to choose from, and we don't see that changing anytime soon.

More Can Be Better

I'm getting ready to buy a new gaming laptop and monitor. The monitor will be an Acer XB270HU (G-Sync, IPS, 144Hz). Should I get a laptop with a 4790K CPU and a single Nvidia 980M GPU? Or should I get one with a 4910MQ mobile CPU and Nvidia 980M SLI? Which will do a better job of taking advantage of the monitor's frame rate? I play both RTS and FPS games. **—Jim Pinder**

ONLINE MANAGING EDITOR JIMMY THANG RESPONDS: Hi Jim, while there are games out there without SLI support, in most cases, having two graphics cards trumps having one graphics card plus a better CPU. Considering the 4910MQ is still an i7 quad-core proc, you shouldn't get CPU bottlenecks.

Lickable Mouse?

I drooled a little over some of the holiday gift suggestions, but feel I owe my two cents on what real computer users need (and some we don't). 1) A laptop we can put in the dishwasher after spilling toast crumbs and coffee on it. 2) Malware and viruses that make our systems run better. 3) Video games that help us solve real-world problems. 4) Chrome-plated peripherals for the bling factor. 5) A great-tasting mouse we can lick when we get hungry. 6) Wireless everything, so we never have to deal with cable clutter again. **—Dave**

> HERE'S A HOLIDAY GIFT SUGGESTION... A GREAT-TASTING MOUSE TO LICK WHEN WE GET HUNGRY.

Getting Touchy

A couple of years ago, when Windows 8 was gaining traction, you had articles reviewing touchscreen panels for desktop computers. I'd stashed one for a future build that never came to fruition. With Windows 10 on the horizon, and its revamp to move away from touchscreen-centric features, I'm wondering if there's still a future for the touchscreen panel on the desktop? **—Rob Monteiro**

ONLINE MANAGING EDITOR JIMMY THANG RESPONDS: Windows 10 will still support touchscreen monitors. As for whether there's still a place for it, well, we'd say it's a nice-to-have feature, but certainly not mandatory. It works well for all-in-one PCs because you can angle them back and use them while standing. As for the desktop experience, it's occasionally nice to be able to tap on a link or shut down the machine with your finger, but we wouldn't recommend paying a premium for it at this point.

Oops! Our Bad

I'd like to point out an error given on page 94 of the February issue in response to the question titled "4K Video Cards." The reader asked for recommendations for GPUs to support 4K resolution. The response equated two Titan Blacks with a total of 12GB of VRAM to three 980X with 4GB each. This is true if you add the VRAM across all cards, but it implies the three 980X cards would equal two Titan Blacks in regard to available memory to support high resolutions and large textures. But the VRAM is not cumulative; it's dedicated to the individual card/frame buffer. **—Anthony Carden**

TECHNICAL EDITOR TOM MCNAMARA RESPONDS: Yeah, that was a boo-boo. Our bad! If we're talking about GPU compute, then a programmer can access each frame buffer independently. But for gaming duties, dual Titans would have 6GB total, and three GTX 980s would have 4GB total. The raw horsepower of three 980s would be stronger than the Titans, but the Titans would have a larger frame buffer. However, the pixel density with a single 4K panel is high enough that you don't need too much antialiasing, which can otherwise eat up a lot of VRAM at higher resolutions. So 4GB isn't a deal-breaker in that particular scenario.

Facebook Polls

Dream Gadgets

What hot new gadgetry are you hoping to snag this year? We put the question out to Facebook and Twitter. Here are some of our favorite responses.

Ben Pearman: A DDR4 system capable of 128GB+ of RAM to set up an upgraded ESXi host to upgrade my current setup.

Tim Micheals: HoloLens.

Patrick McCullough: Replace my last AMD CPU with Intel. The cost to switch is not currently worth it, but maybe this year.

Michael Flynn: A VR headset and a VR *Pokémon* game? Too much to ask for?

Tyler Short: I'd like a security camera or two to help protect my pre-existing gadgets.

Kyle Hewitt: Games that release on time, death of pre-order, release of full game instead of breaking up into DLC. Smartphone with more internal memory, that lasts a few days even with GPS and heavy Internet use. More electric cars, trucks, and buses.

Aaron Leonard: Skylake.

Brian Bartels: Simple. A Blu-ray burner.

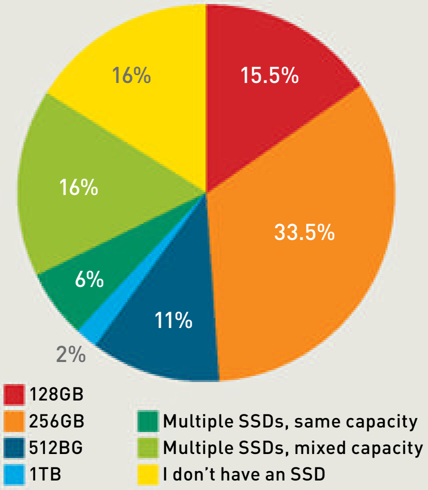
Joshua Novak: VR Headset, fo sho.

Kazzerigian: Moar X99, cheaper and larger SSDs, Server OSes/NAS/storage arrays.

Travis Richard: Hoping for a videocard that doesn't downclock right out the box.

Joseph Dav: A PC! I have the case, power supply, and GPU. Saving for the rest.

SSDs are dropping prices and going up in capacity. How big is yours?



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INGREDIENTS

PART		PRICE
Case	NZXT Source 210 Elite	$50
PSU	Corsair CX500M 500W	$45
Mobo	Gigabyte H97-D3H **NEW**	$95
CPU	Intel Core i3-4150	$120
GPU	XFX Radeon R9 285 R9-285A-CDFC **NEW**	$186
RAM	2x 4GB Patriot Viper 3 Low Profile DDR3/1600 **NEW**	$62
SSD	120GB SanDisk Ultra II	$70
HDD	Seagate Barracuda 1TB	$60
OS	Windows 8.1 64-bit OEM	$100

Approximate Price: $788

WE'VE MADE A FEW UPGRADES since last month, increasing the price by about $35. The main change is the videocard. We've swapped the Radeon R9 280 with the newer 285. It has 2GB of VRAM instead of 3GB, but that shouldn't matter if you're playing at 1920x1080. It's faster overall, and competitive with the Nvidia GTX 960, thanks in part to AMD's new "Omega" driver package. We've upgraded the motherboard from microATX to full ATX, giving you more RAM slots and PCI Express slots. This mobo also has M.2 and SATA Express. So overall, you get some nice storage options for the money. The CPU, case, power supply, and SSD remain competitive value, though the jump to 250GB SSDs is getting smaller and smaller.

INGREDIENTS

PART		PRICE
Case	Corsair Vengeance C70	$108
PSU	EVGA SuperNOVA 850 G2 **NEW**	$99
Mobo	MSI Z97 Gaming 5	$147
CPU	Intel Core i5-4690K	$210
Cooler	Cooler Master Nepton 280L	$100
GPU	Sapphire Tri-X Radeon R9 290	$250
RAM	2x 4GB Patriot Viper 3 Low Profile DDR3/1600 **NEW**	$62
Optical Drive	Samsung SH-224DB/BEB	$20
SSD	240GB SanDisk Ultra II **NEW**	$100
HDD	Seagate Barracuda 3TB ST3000DM001	$103
OS	Windows 8.1 64-bit OEM	$100

Approximate Price: $1,299

THE SEASONIC X-SERIES POWER SUPPLY is now back to its regular price, but we found the highly rated EVGA SuperNOVA G2 on sale for $100 after a mail-in rebate (MIR). That's a good deal for 850 watts of "gold" rated efficiency, and the 10-year warranty doesn't hurt, either. RAM prices are always fluctuating, and we found these Patriot sticks for only $62 after an $8 MIR. The Crucial M550 SSD shot up to $130, so we're switching to a SanDisk Ultra II. Our remaining parts offer a good balance of price and performance, and the MSI Gaming 5 motherboard has a lot of features for the price. A 280mm radiator may be overkill for an Intel Core i5 CPU, but its 140mm fans can operate more quietly than 120mm units.

TURBO

YOU MIGHT THINK a 1,300-watt power supply is silly. But if you run four EVGA GTX 980 cards instead of the two here, you're going to be pulling about a kilowatt of power (assuming some CPU overclocking, too). So we swapped the SeaSonic X-1050 with EVGA's SuperNOVA G2, which had a large mail-in rebate available, making it roughly the same price. The Corsair Vengeance LPX are a little cheaper than the Crucial sticks we had last month, and we like some variety. We've switched the SSD from a Crucial M550 to a Samsung 850 EVO, which has great performance, a lower price, and some nice software.

This X99 Gigabyte board is fine as long as you have the latest BIOS update, but we'll be looking at some more mobos in the future that might replace it, so stay tuned. AMD recently cut the price of its Radeon 290X to just $300, making it pretty tempting. If you plan to run no more than two cards, it's a great alternative. Past that, though, the power demands make it difficult to recommend.

For more of our component recommendations,
visit www.maximumpc.com/best-of-the-best.

INGREDIENTS

PART			PRICE
Case	Corsair Obsidian 750D		$140
PSU	EVGA SuperNOVA 1300 G2	**NEW**	$146
Mobo	Gigabyte GA-X99-UD4		$240
CPU	Intel Core i7-5820K		$390
Cooler	Cooler Master Nepton 280L		$100
GPU	2x EVGA GeForce GTX 980 Superclocked ACX 2.0		$1,100
RAM	4x 4GB Corsair Vengeance LPX DDR4/2400 4x4GB	**NEW**	$213
Optical Drive	LG Blu-ray Burner WH16NS40		$70
SSD	Samsung 850 EVO 500GB	**NEW**	$230
HDD	Seagate Barracuda 3TB ST3000DM001		$103
OS	Windows 8.1 64-bit OEM		$100

Approximate Price: $2,832

UPGRADE OF THE MONTH

EVGA GEFORCE GTX 960 SSC

Nvidia's newest midrange card is nicely represented by longtime partner EVGA. Its operating temperatures are super low, to the point where its already quiet fans don't even need to spin sometimes. It's also respectably overclocked out of the box, yet it needs only one 8-pin PCI Express power cable.

$210, www.EVGA.com

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